LONG-TERM STEWARDSHIP CASE STUDY REPORT

Office of Long-Term Stewardship
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EXECUTIVE SUMMARY

Available documents for seven DOE management decisions (five site specific and two programmatic) were analyzed to evaluate the degree to which long-term stewardship was considered in the past decision-making process. The seven decisions analyzed were:

- Site-Specific Decisions
  - Fernald On-Site Waste Disposal Facility;
  - INEEL Test Area North Remediation Project;
  - Mound Site Property Transfer and HS/RTG Facility;
  - Savannah River Site High-Level Waste Tank Closure; and
  - Weldon Spring Site Remedial Action Project.
- Programmatic Decisions
  - Treatment and Disposal of Low-Level Waste and Mixed Low-Level Waste; and
  - Tritium Supply and Recycling Strategy.

This report does not re-open past decisions for evaluation and critique. The objective is to highlight lessons learned from these decisions in order to make recommendations, inform future decisions, and improve the integration of long-term stewardship into the decision making process.

The seven case studies are included as Appendices to this report.

The analyses of these decisions were conducted to identify how, and to what extent, long-term stewardship considerations factored into the identification and evaluation of alternatives. However, this report does not re-open past decisions for evaluation and critique. The objective is to highlight lessons learned from these decisions in order to make recommendations, inform future decisions, and improve the integration of long-term stewardship into the decision making process.

These seven projects were selected to cover a broad range of DOE decisions, including site remediation; site-specific and programmatic waste management; mission siting and design; and real property transfer. This document is based solely on a review of documents that are readily available to the public, including CERCLA documents, NEPA documents, Records of Decision, Feasibility Studies, Environmental Assessments, and Environmental Impact Statements. The analyses did not include a review of DOE project files or other materials that may contain more detailed information about the decisions, or interviews with individuals involved in the decision-making process. This was intentional, in part to assess the quality of information available to the public that pertains to long-term stewardship.

Several broad conclusions can be drawn from the case studies:

- Documentation of LTS consideration in decision-making is inconsistent across sites. Documentation of sites' analyses of LTS is often incomplete. Available documentation did not always provide explicit information concerning how the long-term stewardship implications of DOE decisions were considered during the decision-making process.

Thus, it was not always clear whether long-term stewardship was explicitly considered in these decisions. For some decisions, long-term stewardship elements are only addressed implicitly, through, for example, application of CERCLA remedy selection criteria. For other decisions, documentation clearly articulated how long-term stewardship issues were considered throughout the decision-making process.

- The long-term effectiveness and permanence of proposed solutions and decisions were not adequately evaluated. In some cases, long-term stewardship issues were identified, and remedies were proposed, but detailed plans and procedures to effectively carry out the remedies were not developed. For example, where institutional controls were proposed to address long-term stewardship issues, available documentation did not identify the specific institutional controls that would be used and how they would be funded and enforced over time. Economic redevelopment is a goal at many DOE sites, but this review did not identify any policies, implementing guidance, or procedures for ensuring the long-term effectiveness and permanence of engineered and institutional controls in cases where real property had been leased or sold to private companies.

- Available documentation generally did not describe the complete set of activities to be conducted over the life-cycle of each alternative considered for the decision. For example, life-cycle planning identified activities related to operation of proposed alternatives, but did not take into account activities related to the long-term maintenance and/or replacement of the proposed alternatives.

- Standard life-cycle cost estimation techniques may not be appropriate for long-term stewardship. DOE generally bases cost estimates for its decisions on a 30-year "net present worth" cost estimate. The net present worth method discounts future dollar expenditures and therefore the actual costs of all future activities. The net present worth methodology and the 30-year time frame may not be the most appropriate technique for accounting for the costs of long-term stewardship activities, which may be needed in perpetuity. Moreover, DOE has not issued guidance on alternative methods for evaluating long-term stewardship costs.

As a result of these and other observations, this report has the following recommendations:

1. Develop a set of standard decision making criteria to identify and evaluate the long-term stewardship implications of alternatives and decisions. Such criteria should be used from the beginning of the decision-making process through final selection of the alternative.

2. Long-term effectiveness and permanence should be primary criteria used to identify and evaluate all alternatives. In addition to identifying and proposing a solution to a long-term stewardship issue, decision documents should also detail how the solution will be managed, maintained, and remain effective over time.

3. Develop standard protocols for documenting how long-term stewardship was considered in all decisions. These protocols should provide a basis for developing scenarios and criteria for evaluating the long-term effectiveness and permanence of remedies, the scope and cost of long-term stewardship activities, and the constraints imposed by each

alternative. The protocols, moreover, should result in an improved public record for decisions affecting long-term stewardship.

4. Develop life-cycle planning and analysis methodologies, including scenario analysis and qualitative risk analysis, that adequately plan for and assess the activities to be conducted over the entire life-cycle of all decisions and alternatives considered for long-term stewardship. Such planning and analysis, moreover, should then be incorporated into the decision making process in an effort to enhance the long-term effectiveness and permanence of selected remedies over their entire life-cycle.

5. Develop alternative life-cycle cost estimating techniques and timeframes that more accurately account for the cost of long-term stewardship activities, time horizons and uncertainties in the evaluation of alternatives.

A brief description of the specific analyses and conclusions for each case study follow.

Fernald On-Site Waste Disposal Facility – The Fernald Environmental Management Project Operable Unit 2 (OU2) includes waste units that held materials not considered hazardous enough to require treatment. In a ROD published May 15, 1995, DOE selected as the remedy for OU2 excavation and on-site disposal facility (OSDF) of most of the radioactive waste from OU2, and off-site disposal of radioactive waste that did not meet on site waste acceptance criteria. The case study focuses on the OU2 remedy selection process and the decision to construct the OSDF. This case study has three main conclusions: (1) As a result of the decision to build the OSDF, long-term stewardship obligations for DOE were created at the FEMP that could have otherwise been minimized or avoided; (2) The net present worth methodology does not provide an unbiased evaluation of situations where DOE is required to incur long-term stewardship costs in perpetuity; and (3) DOE's policy of splitting up the burden of waste disposal among sites and states, if applied throughout the DOE complex, could result in DOE having to conduct long-term stewardship activities in perpetuity at dozens of additional sites.

INEEL Test Area North Remediation Project – Test Area North (TAN) is one of ten waste area groups at the Idaho National Engineering and Environmental Laboratory (INEEL) that are undergoing cleanup. Eight remediation sites within TAN were evaluated in the *Remedial Investigation/ Feasibility Study for Test Area North Operable Unit 1-10*, and had remedial actions decisions recorded in the *Final Record of Decision for Test Area North*. The remedy selection processes for these eight sites are the principal focus of this case study. This case study concludes that, with the exception of one remedy selection (Burn Pits), the decision-making process for the TAN sites resulted in DOE minimizing long-term stewardship needs at the TAN sites and consolidating long-term stewardship activities at a smaller number of disposal facilities. This will most likely reduce DOE's long-term stewardship costs as compared with in-situ treatment and disposal of wastes at the TAN sites. The selected remedy for the Burn Pits creates long-term stewardship needs and costs at TAN that need not have been created, as excavation, treatment, and disposal of the Burn Pits wastes would have consolidated long-term stewardship needs and costs for the Burn Pits waste at an on-site or off-site disposal facility.

Mound Site Property Transfer and HS/RTG Facility – The Miamisburg Environmental Management Project, formerly known as Mound Plant, is located within the city of Miamisburg, Ohio. DOE is presently in the process of cleaning up the Mound Plant, with the ultimate objective and mission of transferring most of the site to a non-DOE entity known as the Miamisburg Mound Community Improvement Corporation (MMCIC) for economic redevelopment. This case study analyzes the long-term stewardship implications of two decisions: (1) The DOE program decision to privatize ownership of the site and transfer individual parcels of DOE real property by sale or lease to MMCIC; and (2) The decision to keep the HS/RTG operation at the Mound site, after analyzing different options to transfer the operation to other DOE facilities. This study concludes that these decisions raise two significant long-term stewardship issues: (1) Due to residual contamination, DOE or another entity must effectively implement, enforce, fund, and maintain institutional controls throughout the privatization process and over the long-term management of the site in order to ensure adequate protection of public health; and, (2) Continued operation of the HS/RTG at Mound will require DOE to maintain a small facility handling nuclear materials in close proximity to the public.

Savannah River Site High-Level Waste Tank Closure – DOE prepared the *Environmental Assessment for Closure of the High-Level Waste Tanks in F- and H- Areas at the Savannah River Site* in July 1996. In the spring of 1997, following the completion of the Environmental Assessment and a subsequent *Finding of No Significant Impact*, two of the HLW tanks in the F-Tank Area were closed by removing bulk HLW from the tanks and then filling the tanks with grout and concrete. The case study for the SRS HLW Tank Closure analyzes the selection of closure method for the two F-Area tanks that have already been closed but does not evaluate the decision-making process for the closure of the remaining tanks in F- and H-Areas. There are six broad conclusions from this study. Available documentation does not address: (1) how DOE specifically identified the needs and costs of long-term stewardship for each of the alternatives considered in the Environmental Assessment; (2) how the consideration of long-term stewardship affected the range of alternatives identified by DOE; (3) how the alternatives vary substantively with respect to their overall protectiveness; (4) how the alternatives meet the FFA requirement to maintain the integrity of the tanks; (5) whether the distinction between "interim" and "permanent" remedies would have led to a different preferred alternative; and (6) how DOE intends to enforce institutional controls and land use restrictions for the required time period.

Weldon Spring Site Remedial Action Project – The Weldon Spring Chemical Plant Area is one of four operable units that make up the Weldon Spring Site Remedial Action Project. The CERCLA process for screening and analyzing remedial alternatives, and selecting a remedial action is documented in a Feasibility Study and ROD for the operable unit. This case study focuses on the decision-making process for remediation of the Chemical Plant Operable Unit. This study concludes that Weldon Spring incorporated long-term stewardship in its decision making process. Our analysis indicates that a predictable, reliable, and cost-effective remedy over the long-term was selected. Long-term stewardship concerns were reflected in the remedy screening and remedy selection criteria. Additionally, components of long-term stewardship were incorporated into the analyses of costs, risks, and effectiveness.

Treatment and Disposal of DOE LLW and MLLW – The *Final Waste Management Programmatic Environmental Impact Statement* (PEIS) for treatment, storage, and disposal of radioactive and hazardous waste issued in May 1997, examined the environmental impacts of managing more than two million cubic meters of radioactive wastes from past, present, and future DOE activities. This case study examines only the portion of the WM PEIS and the associated Record of Decision (ROD) that focus on the treatment and disposal of low-level radioactive waste (LLW) and mixed low-level radioactive waste (MLLW). This study concludes that the available documentation does not address how the decision-making process evaluated the entire proposed program for the disposal and treatment of low-level waste and mixed low-level waste with respect to long-term stewardship. Long-term stewardship needs and costs were not identified or evaluated in the decision documents for the alternatives, and therefore potential differences in the long-term stewardship characteristics of the alternatives could not be addressed fully in this study. The available documentation does indicate that the life-cycle costs analysis did not take into account the long-term care and maintenance of the treatment and disposal facilities in the post-closure phase. Total life-cycle cost estimates by waste-type alternatives were presented using a cost estimation process involving existing technologies and historical industrial costs. Furthermore, the period of time to which costs were extrapolated does not allow for any consideration of long-term stewardship issues, i.e., the Final WM PEIS considered a 20-year waste management period to estimate such costs.

Tritium Supply and Recycling Strategy – DOE's tritium strategy involved the establishment of tritium supply options by 2005. Technology and siting alternatives for production of tritium were analyzed in a Programmatic Environmental Impact Statement (PEIS) published in October 1995. The case study focuses on the three decision components of the Tritium Supply and Recycling Strategy. This study concludes that the available documentation does not address how long-term stewardship issues were evaluated in the decision-making process. More specifically, the available documentation does not address how DOE evaluated the environmental impact, long-term stewardship obligations and life-cycle costs of the *total* action involved in tritium production, including tritium-producing burnable absorber rods (TPBAR) fabrication, extraction of the tritium, decontamination and decommissioning (D&D).

TABLE OF CONTENTS

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1. INTRODUCTION

This Long-term Stewardship Case Study Report consists of an analysis of seven recent DOE projects involving a management decision. Five of these were site-specific decisions; two were programmatic decisions. Each case study describes the management decision, the alternatives considered in the decision making process, the criteria used to evaluate the alternatives, the extent to which long-term stewardship was considered in the decision making process, and the implications of the decision with respect to DOE's long-term stewardship obligations. DOE acknowledges that the political, economic and regulatory context surrounding each decision is different. It is also important to note that the Department's understanding of long-term stewardship goals and obligations has increased since many of these decisions were made. Therefore, the analyses of these decisions provide useful insight for *future* decisions. The purpose of this report is not to evaluate or critique each decision. Rather, the primary objectives of this report are:

1. To identify the relevant lessons learned from each decision to improve long-term stewardship planning and implementation; and

2. To highlight the information needed to integrate long-term stewardship planning into future decisions and initiatives and document how LTS was considered in these decisions/initiatives.

The remaining sections of this report describe the methodology used in identifying and analyzing the seven decisions, a description of the decisions analyzed, observations and lessons learned, and recommendations and next steps. The case studies for each of the seven decisions analyzed are included as Appendices to this report.

2. METHODOLOGY

This report is based solely on a review of documents that are readily available to the public, including Records of Decision, Feasibility Studies, Environmental Assessments, and Environmental Impact Statements. This document does not include a review of DOE project files or other materials that may contain more detailed information about the decisions, or interviews with individuals involved in the decision-making process.

These seven projects were selected to cover a broad range of DOE decisions, including site remediation pursuant to CERCLA; site-specific and programmatic waste management; mission siting and design; long-term stewardship planning; and real property transfer.

2.1 Site-Specific Decisions Analyzed

1. **Fernald On-Site Waste Disposal Facility –** The Fernald Environmental Management Project Operable Unit 2 (OU2) includes waste units that held materials that were not considered hazardous enough to require treatment. In a ROD published May 15, 1995, DOE selected as the remedy for OU2 excavation and on-site disposal of most of the radioactive waste from OU2, with off-site disposal of radioactive waste that did not meet on site waste

acceptance criteria. Upon completion in 2006, the On-Site Disposal Facility (OSDF) will consist of a 2.5 million cubic yard low-level radioactive waste disposal facility with a multi-layer cap and liner system and leachate conveyance system. DOE analyzed four remedial alternatives in detail for OU2, including Alternative 1: *No Action,* Alternative 2: *Consolidation and Capping,* Alternative 3*: Excavation and Off-Site Disposal,* and Alternative 6: *Excavation and On-Site Disposal with Off-Site Disposal of Fraction Exceeding Waste Acceptance Criteria.* Alternatives 4, 5, 7, and 8 were screened out during the Feasibility Study process. The case study focuses on the OU2 remedy selection process and the decision to construct the OSDF.

2. **INEEL Test Area North Remediation Project –** Test Area North (TAN) is one of ten waste area groups at the Idaho National Engineering and Environmental Laboratory (INEEL) that are undergoing cleanup. Eight remediation sites within TAN were evaluated in the *Remedial Investigation/ Feasibility Study for Test Area North Operable Unit 1-10,* and had remedial actions decisions recorded in the *Final Record of Decision for Test Area North*. These sites include the V-Tanks, PM-2A Tanks, Soil Contamination South of the Turntable, Disposal Pond, Burn Pits, and Fuel Leak Area. The remedy selection processes for these eight sites are the principal focus of the INEEL Test Area North case study.

3. **Mound Site Property Transfer and HS/RTG Facility –** The Miamisburg Environmental Management Project (MEMP), formerly known as Mound Plant, is located within the city of Miamisburg, Ohio. The Mound Plant commenced operation in 1948 and has conducted Isotopic Heat Source Radio Isotope Thermoelectric Generator (HS/RTG) assembly test operations for over 15 years. DOE is presently in the process of cleaning up the Mound site, with the ultimate objective and mission of transferring most of the site to a non-DOE entity known as the Miamisburg Mound Community Improvement Corporation (MMCIC) for economic redevelopment. This case study analyzes the long-term stewardship implications of two decisions: (1) the DOE program decision to privatize ownership of the site and transfer individual parcels of DOE real property by sale or lease to MMCIC; and (2) the decision to keep the HS/RTG operation at the Mound site, after analyzing different options to transfer the operation to other DOE facilities.

4. **Savannah River Site High-Level Waste Tank Closure –** DOE prepared the *Environmental Assessment for Closure of the High-Level Waste Tanks in F- and H- Areas at the Savannah River Site* in July 1996. In the spring of 1997, following the completion of the Environmental Assessment and a subsequent *Finding of No Significant Impact*, two of the HLW tanks in the F-Tank Area were closed by removing bulk HLW from the tanks and then filling the tanks with grout and concrete. Twenty-two HLW tanks remain open in the Savannah River Site (SRS) F-Tank Area, and twenty-nine more are located in the H-Tank Area. On December 29, 1998, DOE released a Notice of Intent to prepare an Environmental Impact Statement (EIS) for closure of the remaining HLW tanks. DOE will select a methodology for closure of the remaining tanks in the Record of Decision (ROD) for the EIS. The case study for the SRS HLW Tank Closure analyzes the selection of closure method for the two F-Area tanks that have already been closed but does not evaluate the decision-making process for the closure of the remaining tanks in F- and H-Areas.

5. **Weldon Spring Site Remedial Action Project –** The Weldon Spring Chemical Plant Area is one of four operable units that make up the Weldon Spring Site Remedial Action

Project. The CERCLA process for screening and analyzing remedial alternatives, and selecting a remedial action is documented in a Feasibility Study and ROD for the operable unit. This case study focuses on the decision-making process for remediation of the Chemical Plant Operable Unit. The remedial action that was selected for the Chemical Plant Operable Unit consisted of: 1) excavation of all the waste; 2) chemical stabilization and/or volume reduction of some of the waste; and 3) disposal of the waste in an engineered on-site disposal facility. As part of this remedy, two treatment facilities and an on-site disposal facility have been built on the Weldon Spring Site. The remedy is expected to be fully completed in 2001. A long-term stewardship plan is being developed for the Weldon Spring Site, including the Chemical Plant Operable Unit. The draft long-term stewardship plan for the site also is described in this case study.

2.2 Programmatic Decisions Reviewed

6. **Treatment and Disposal of DOE LLW and MLLW –** The *Final Waste Management Programmatic Environmental Impact Statement* (PEIS) for treatment, storage, and disposal of radioactive and hazardous waste issued in May 1997, examined the environmental impacts of managing more than two million cubic meters of radioactive wastes from past, present, and future DOE activities. The PEIS analyzed alternatives for treatment and disposal of four types of radioactive waste, including low-level radioactive waste (LLW), mixed low-level radioactive waste (MLLW), and other types of wastes generated by defense and research activities at 54 DOE sites. The case study analyzes the Waste Management PEIS and ROD published February 25, 2000 for treatment and disposal of LLW and MLLW, including DOE's treatment and disposal options and selected alternatives, but does not analyze DOE decisions for treatment and disposal of other types of wastes.

7. **Tritium Supply and Recycling Strategy –** DOE's tritium strategy involved the establishment of tritium supply options by 2005. Technology and siting alternatives for production of tritium were analyzed in a Programmatic Environmental Impact Statement (PEIS) published in October 1995. Based on the findings in the PEIS and other cost, technical, and schedule evaluations, DOE issued a ROD on December 5, 1995. DOE decided to pursue a dual-track approach: (1) purchase an existing (operating or partially complete) commercial light water reactor (CLWR) or contract irradiation services from a CLWR; and (2) design, build, and test critical components of an accelerator for tritium production. The Savannah River Site was selected in the 1995 ROD as the location for an accelerator for production of tritium, should one be built. The case study focuses on the three decision components of the Tritium Supply and Recycling Strategy, including selection of the dual-track approach for the project and selection of the SRS location.

3. OBSERVATIONS AND LESSONS LEARNED

3.1 Documentation of How Long-term Stewardship was Considered During the Decision-making Process

Available documentation did not always provide explicit information concerning how the long-term stewardship implications of DOE decisions were considered during the decision-making process. Thus, it was not always clear whether long-term stewardship was explicitly considered in these decisions. For some decisions, long-term stewardship elements are only addressed implicitly, through, for example, application of CERCLA remedy selection criteria. Different levels of knowledge, different terminology and language, and various methods of incorporating long-term stewardship into the decision making process were found for many of the seven case study. While every site presents unique long-term stewardship conditions and issues, the public record for decisions affecting long-term stewardship could be improved with a more standardized approach to documenting and analyzing long-term stewardship issues.

For example, available documentation for the Savannah River Site High-Level Waste Tanks Closure study did not explicitly address how DOE identified the needs and costs of long-term stewardship for each of the alternatives considered in the Environmental Assessment. Available documentation also did not indicate if DOE considered long-term stewardship needs and costs as criteria in its decision-making process, or how this potential over-sight affected the range of alternatives identified by DOE.

However, documentation for other decisions, such as the Weldon Spring Remedial Action Project, clearly articulated how long-term stewardship issues were considered throughout the decision making process. Consideration of long-term stewardship in the remedy selection process resulted in a predictable, reliable, and cost-effective remedy over the long-term. The decision-makers chose chemical stabilization because it was more reliable than other treatment procedures, and the technical limitations of chemical stabilization prevented disposal of the treated waste anywhere off-site. The selected remedy minimized dependence on long-term stewardship, as it included treatment (stabilization and volume reduction) of the waste, and disposal of the waste in an engineered facility. As a result, contaminated waste is stabilized, consolidated, and isolated from the environment. These measures helped reduce the short-term and long-term risk to human health and the environment, and the scope of long-term stewardship activities.

3.2 Long-term Effectiveness and Permanence

In many cases, long-term stewardship issues were identified, and remedies were proposed, but detailed plans and procedures to effectively carry out the remedies were not developed. Institutional controls, for example, were proposed at some sites to address long-term stewardship issues such as access to, and use of, a resource (i.e. property or groundwater). However, documentation was not always provided detailing the specific institutional controls that would be used; how the institutional controls would be funded; and how the institutional controls would be enforced over time.

For example, for the SRS HLW Tanks Closure study, available documentation did not address how DOE would enforce institutional controls and land use restrictions. The Environmental

Assessment assumed that institutional controls (deed restrictions to restrict groundwater use) for the site will remain effective for a 10,000 year period after closure of the tanks, and that land use for the site will remain strictly industrial over the same time period. Available documentation did not indicate the types of institutional controls that will be required at the site to restrict land use to industrial use, nor how such land use restrictions will remain effective over a 10,000 year period.

In another example, DOE assumed for Fernald that a clay cap would maintain its integrity for a 1,000 year period. The uncertainties associated with this assumption were not clearly discussed in decision documents. For example, the integrity of the cap is dependent upon the continued maintenance of site access restrictions and other institutional controls that may or may not remain effective over a 1,000 year period. In this instance, the long-term effectiveness of the clay cap were not evaluated in conjunction with the long-term effectiveness and permanence of institutional controls.

3.3 Life-Cycle Analysis

Available documentation suggests that full life-cycle planning and analysis are not always incorporated into management decisions. For example, in the programmatic decision regarding the treatment and disposal of low-level waste and mixed low-level waste, available documentation indicated that the life-cycle cost analysis did not take into account the long-term care, maintenance and potential replacement of the treatment and disposal facilities in the post-closure phase. The Final WM PEIS projected estimated costs for only a 20-year waste management period. This estimation timeframe does not project far enough into the future to plan for and evaluate long-term maintenance and/or replacement of the facilities. This does not allow for an adequate consideration of long-term stewardship issues and may not fully recognize the need to conduct long-term stewardship in perpetuity.

Decision documents did not necessarily describe the full life cycle of alternatives explicitly or discuss long-term stewardship implications and factors for the decision specifically. Technical and other uncertainties may make it difficult to consider life-cycle effects of alternatives. However, techniques are available (e.g., scenario analysis, qualitative risk analysis) for considering potential future changes (e.g., demographics, regulations, new technologies, land use) and how they affect risk management. For example, available documentation for the Tritium Supply and Recycling Strategy project did not address how DOE evaluated the environmental impact and life-cycle costs of the *total* action involved in tritium production, including tritium-producing burnable absorber rod (TPBAR) fabrication, tritium extraction, decontamination and decommissioning (D&D), and long-term stewardship of all these facilities.

3.4 Cost Estimation

Standard cost estimation techniques may not be appropriate for long-term stewardship. DOE generally bases cost estimates for its decisions on a 30-year "net present worth" cost estimate. The net present worth method discounts future dollar expenditures and therefore the actual costs of all future activities. The net present worth methodology and the 30-year time frame may not effectively capture the expenses associated with the need to conduct long-term stewardship in perpetuity. The present value of future costs is effectively zero after several decades. Therefore, an alternative having lower initial construction and operating costs will almost always have a lower life-cycle “cost” (based on net present worth) than alternatives having higher initial costs, even if the former alternative requires DOE to incur long-term stewardship costs in perpetuity and the latter alternative only requires DOE to incur long-term stewardship costs only for several decades. Discounting may therefore not provide the most appropriate methodology for evaluating long-term stewardship in decisions.

4. RECOMMENDATIONS

This section provides recommendations to improve the consideration and documentation of long-term stewardship issues in future programmatic or site specific management decisions.

1. Improve Consistency of Decision-Making: Develop a set of standard decision making criteria and implementation guidance to identify how long-term stewardship should be considered and evaluated in DOE management decisions. Decision criteria for long-term stewardship should be used from the beginning of the process through final selection of the alternative. Implementation guidance should cover critical aspects of long-term stewardship, including, but not limited to:

   – Oversight plans;
   – Cost estimates;
   – Life-cycle analyses;
   – Long-term effectiveness and permanence;
   – Funding mechanisms;
   – Emergency planning, response and training;
   – Use of engineered and institutional controls;
   – Scenario and qualitative risk analyses;
   – Stakeholder involvement; and
   – Time estimates for DOE involvement.

   The long-term stewardship plan developed for the Weldon Spring Site may be useful as an initial template for other sites developing long-term stewardship plans. The draft plan identifies several activities that must be accomplished to successfully implement long-term stewardship, including: establishing authority and funding for stewardship activities; identifying stewards and assigning responsibility; identifying enforcement authority; and incorporating corrective actions and contingency plans to address possible adverse effects.

2. Long-term Effectiveness Criteria: Long-term effectiveness and permanence should be primary criteria used to identify and evaluate all alternatives. In addition to identifying and proposing a solution to a long-term stewardship issue, decision documents should also detail how the solution will be managed, maintained, and remain effective over time.

3. Improve Documentation of DOE Decisions: Develop standard protocols for documenting how long-term stewardship was considered in all decisions. These protocols should provide a basis for developing scenarios to be evaluated, assumptions used, and criteria for evaluating the long-term effectiveness and permanence of remedies, the scope and life-cycle cost of long-term stewardship activities, and the constraints imposed by each alternative.

The protocols should result in an improved public record for decisions affecting long-term stewardship.

4. Develop Life-Cycle Planning and Analysis Methodologies: Develop life-cycle planning and analysis methodologies, including scenario analysis and quantitative risk analysis, that adequately assess activities to be conducted over the entire life-cycle of all decisions and alternatives. Such planning and analysis, moreover, should then be incorporated into the decision making process in an effort to enhance the long-term effectiveness and permanence of selected remedies over their entire life-cycle.

5. Develop Alternative Cost Estimates Methodologies: Develop alternative cost estimating methodologies and time frames that more appropriately account for the cost of long-term stewardship activities, time horizons and uncertainties in the evaluation of alternatives.

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APPENDIX A

FERNALD SITE ON-SITE DISPOSAL FACILITY

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FERNALD SITE ON-SITE DISPOSAL FACILITY

INTRODUCTION

The Fernald Environmental Management Project (FEMP) is a former uranium processing facility. The site, located 18 miles northwest of Cincinnati, Ohio, is located over a high-yield sole-source aquifer, the Great Miami Aquifer. The FEMP is divided into five operational units to organize the remedial action process. Operable Unit 2 (OU2) includes waste units (e.g., sanitary landfill, lime sludge ponds, fly ash piles) that held materials that were not considered hazardous enough to require treatment. This case study addresses the DOE decision to construct an On-Site Disposal Facility (OSDF) for low-level radioactive waste generated from remediation of OU2.

This case study analyzes this decision and its implications for DOE's long-term stewardship obligations. This study includes a description of the decision, the alternatives considered, and decision-making criteria, and evaluates the extent to which long-term stewardship needs and costs were considered in the decision-making process. The study also identifies the implications of the decision with respect to long-term stewardship, specifically whether the decision created long-term stewardship obligations and costs for the DOE that need not have been created.

DESCRIPTION OF PROJECT

On May 15, 1995, the DOE issued a *Final Record of Decision for Remedial Action for Operable Unit 2* at the FEMP. The Record of Decision (ROD) presented the remedial action alternatives that were considered for the site, and the remedial action that was decided upon. The selected remedy for OU2 was the excavation and on-site disposal of most of the radioactive waste from OU2, with off-site disposal of radioactive waste that did not meet waste acceptance criteria established by the State of Ohio for the On-Site Disposal Facility. On-site disposal included the construction and operation of the On-site Disposal Facility (OSDF) and its associated leachate collection and treatment system[1]. Current plans for the FEMP call for ecological restoration of approximately 884 acres of the site. The OSDF and another 23-acre tract are excluded from the restoration acreage.[2]

The On-Site Disposal Facility began operating in December 1997, when the first cell began accepting low-level radioactive waste. Upon completion in 2006, the remedy will consist of an 800 ft x 3700 ft x 60 ft depth waste disposal facility containing-cells with a multi-layer cap and liner system, as well as a leachate conveyance system, a haul road, and a 300-foot buffer zone. Remediation of OU2 is ongoing, but the completed disposal facility will eventually contain 2.5 million cubic yards of low-level radioactively contaminated soil and debris. The OSDF has specific waste acceptance criteria, established by the State of Ohio, based upon concentration limits, size criteria, and the prohibition of certain types of waste. These criteria are described in detail in the Fernald site 1998 Impacted Materials Placement Plan and Waste Acceptance Criteria Attainment Plan. As a result of these criteria, approximately 3,100 cubic yards of radioactively contaminated material will be transported and disposed of off-site.[3] Per an agreement with the State of Ohio, the OSDF is available for disposal of waste from Operating Unit 5 (OU5) as well as waste from OU2, but the OSDF cannot accept any waste generated off-site.[4]

ALTERNATIVES CONSIDERED

The decision was made in accordance with CERCLA requirements. A Remedial Investigation and a Feasibility Study were conducted, and these studies helped to identify the major remedial action alternatives, and analyze the critical issues surrounding the selection of an alternative. The final decision in the ROD was concurred upon by the DOE, U.S. Environmental Protection Agency, and the State of Ohio.[5]

The selected remedy for OU2 was chosen from among eight alternatives identified and analyzed in the *Remedial Investigation Report for Operable Unit 2* at FEMP released in January 1995. Only four of the eight alternatives underwent detailed analysis:[6]

1. *Alternative 1: No Action.* This alternative provided a baseline against which other alternatives can be compared. No remedial action would be taken under this alternative.

2. *Alternative 2: Consolidation and Capping.* This alternative included consolidation of all contaminated materials within or near each of the subunits of OU2 and construction of a cap over the materials.

3. *Alternative 3: Excavation and Off-Site Disposal.* This alternative included excavation of all materials with contaminant concentrations above the established cleanup levels for the Fernald site, processing of the material to reduce size and moisture, and disposal of the material off-site at a commercial low-level waste disposal facility. This alternative would require DOE to obtain an exemption from the requirements of DOE Order 5820.2A, which requires DOE to disposed of DOE-generated waste at DOE facilities[7].

4. *Alternative 6: Excavation and On-Site Disposal with Off-Site Disposal of Fraction Exceeding Waste Acceptance Criteria.* This alternative included excavation of all soils with contaminant concentrations above cleanup levels, processing of the soil to reduce size and moisture, and disposal in an engineered on-site disposal facility. Materials that exceed waste acceptance criteria established for the OSDF will be disposed of off-site.

Alternative 6 was chosen as the selected remedy in the ROD. Alternatives 4, 5, 7, and 8 were screened out during the Feasibility Study process. Alternative 4 included treatment of waste to meet off-site disposal waste acceptance criteria; in fact, no such treatment would be required based on OU2 waste characteristics. Alternative 5 included on-site disposal of *all* of the OU2 waste without treatment. This alternative was screened out because it would not meet ARARs. Alternatives 7 and 8 included on-site disposal of the OU2 waste with waste treatment prior to disposal; both these alternatives were deemed to provide no added benefit over Alternative 6 with respect to effectiveness, but had lower implementability and higher cost than Alternative 6.

DECISION-MAKING CRITERIA

Nine criteria were used to evaluate the alternatives.[8] These criteria are consistent with the requirements set forth under CERCLA for evaluating and selecting remedies.

1. *Overall Protection of Human Health and the Environment* – addresses whether or not a remedy provides adequate protection, and describes how risks posed through each pathway are eliminated, reduced, or controlled through engineering or institutional controls.

2. *Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)* – addresses whether or not a remedy will meet all of the ARARs of other Federal or State environmental statutes and/or provide grounds for invoking a waiver.

3. *Long-Term Effectiveness and Permanence* – refers to the magnitude of residual risk and the ability of a remedy to maintain reliable protection of human health and the environment at the Fernald site over time once cleanup goals have been met.

4. *Reduction of Toxicity, Mobility, or Volume through Treatment* – the anticipated performance of the treatment technologies that may be employed in a remedy.

5. *Short-Term Effectiveness* – refers to the speed with which the remedy achieves protection, as well as the remedy's potential to create adverse impacts on human health and the environment that may result during the construction and implementation period.

6. *Implementability* – the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement the chosen solution.

7. *Cost* – includes the capital and operation and maintenance costs. Net present worth analysis was used to compare the cost of each alternative.

8. *State Acceptance* – indicates whether, based on its review of planning and decision documents, the State concurs with, opposes, or has no comment on the preferred remedial alternative.

9. *Community Acceptance* – will be assessed in the ROD following a review of the public comments received on the planning and decision documents.

The first two criteria are defined by CERCLA as threshold criteria, meaning that they "must be satisfied in order for an alternative to be eligible for selection as the preferred remedial alternative."[9] Criteria three through seven are defined as primary balancing criteria, meaning that these criteria are used to weigh the alternatives. Criteria eight and nine are defined as "modifying criteria," which means they are taken into account after public comment is received on the Proposed Plan.

CONSIDERATION OF LONG-TERM STEWARDSHIP IN THE DECISION-MAKING

Three of the nine remedy evaluation criteria explicitly considered aspects of long-term stewardship: *Compliance with ARARs, Long-term Effectiveness and Permanence,* and *Cost*. The criterion *Overall Protection of Human Health and the Environment* effectively aggregates the conclusions of the other evaluation criteria. The *State Acceptance* criteria and the *Community Acceptance* Criteria were also important factors in the decision-making process for the OSDF.

Compliance with ARARs

DOE was required under CERCLA to obtain a waiver from ARARs in order to construct the OSDF above a sole source aquifer.[10] Ohio EPA regulation OAC 3745-27-07 identifies areas where solid waste disposal facilities may not be located. The regulation prohibits construction of a solid waste disposal facility above a sole source aquifer or above an unconsolidated aquifer capable of sustaining yield of 100 gallons per minute for a 24 hour period. The location of the OSDF does not meet either of these siting criteria.

OEPA has established policies for allowing exceptions to the siting criteria that indicate that the protection of human health and the environment should be provided solely by the existing hydrological conditions of the site of the proposed solid waste disposal facility. One such exception criteria is that a significant amount of soil exist between the disposal facility and the aquifer to prevent leachate from migrating to the aquifer during the active live of the facility (the period in which waste is disposed of in the facility) and during the post-closure care period (a minimum of 30 years). The location of the OSDF does not meet this criterion based on the possibility that granular soils exist under the OSDF and the need to protect the aquifer for significantly longer than 30 years (i.e., for at least 200 years in accordance with an ARAR under 40 CFR 192). EPA states in 40 CFR 192.02 that disposal facilities must be designed to be effective for up to 1,000 years, to the extent reasonably achievable, and in any case for at least 200 years.

DOE requested a waiver from OEPA based on the degree of protection and level of performance of the remedy and its reliability into the future. DOE concluded that the combination of engineering controls and existing hydrological conditions would provide the same degree of protection of the aquifer as the hydrological conditions described in the OEPA siting criteria waiver policy. DOE conducted modeling for a 1,000 year period and assumed that the liner system and man-made materials of the leachate collection system of the OSDF would fail (the ROD does not indicate the time to failure assumed). DOE assumed for the modeling that the enhanced 12 foot thick clay cap for the OSDF would continue to reduce infiltration into the OSDF over the 1,000 year modeling period. The modeling results estimated that leachate that may eventually reach the aquifer would not cause groundwater concentrations to exceed existing and proposed Maximum Contaminant Levels (MCLs).[11]

With respect to level of performance, modeling results indicated that the combination of the enhanced clay cap for the OSDF combined with the waste acceptance criteria of 346 pCi/g of uranium-238 (1,030 ppm total uranium) would not exceed the proposed MCL for total uranium in groundwater at the boundary of the disposal facility. Models also indicated that a groundwater concentration level based on 10^{-6} excess cancer risk at the boundary of the FEMP. With respect to reliability into the future, DOE indicated that the biotic barrier in the OSDF cap would prevent burrowing animals or vegetative roots from compromising the integrity of the cap, and that the leak detection and monitoring program for the OSDF would provide early warning of any problems with leachate containment and allow corrective measures to be taken prior to adverse impact to the aquifer.[12] The ROD does not indicate whether the leak detection and monitoring program is anticipated to remain in operation during the entire 1,000 year time frame for which modeling was done.

Long-term Effectiveness and Permanence

This criterion focused on the potential impacts that the remedial alternatives would have on human health and the environment, as well as possible methods to mitigate these impacts. The analysis considered how effective each alternative would be in protecting human health and the environment, and what kinds of restrictions or institutional controls would be needed to ensure their effectiveness. The ROD recognized that each remedial alternative would have different long-term stewardship requirements, such as groundwater monitoring, land use restrictions, access restrictions, and monitoring and maintenance of engineered controls.

The ROD concluded that Alternative 3, *Excavation and Off-site Disposal*, "would provide the most effective long-term protection of human health and the environment [at the FEMP] since contaminated material would be excavated and disposed of at an approved off-site disposal facility." However, it was also suggested in the ROD that long-term protection of human health and the environment could be guaranteed for the other alternatives (with the exception of the *No Action* alternative) with the right institutional controls in place. For example, the ROD states that "The long-term effectiveness of the [OSDF] facility would be ensured by federal ownership with access restrictions."[13] The ROD indicates that the U.S. Environmental Protection Agency and the State of Ohio concluded that Alternative 6, *Excavation and On-site Disposal*, represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a cost effective manner for OU2. The ROD concluded that Alternative 6 does not offer as high a degree of long-term effectiveness and permanence as Alternative 3, but also concluded that the selected remedy would significantly reduce the risks from the contaminated material through excavation and placement in an engineered on-site disposal facility.

Cost

The cost analysis for the remedial alternatives evaluated the amount of money (in net present worth) that would be needed to "pay for all construction costs for an alternative, including 30 years of monitoring and maintenance costs following remediation."[14] The ROD used cost data from the *Feasibility Study Report for Operable Unit 2*, which followed Resources Conservation and Recovery Act (RCRA) guidelines for post-closure monitoring and maintenance projections, and therefore only evaluated the costs of each alternative over a maximum post-closure period of 30 years.[15] DOE indicated in the ROD that the net present worth method of cost analysis was used to provide an "unbiased comparison of alternatives with varying construction schedules and monitoring and maintenance costs."[16] For the cost estimate, operating and maintenance costs for each alternative were assumed to be incurred over a 30 year post closure period of operation.

The cost of constructing and operating and maintaining the OSDF (Alternative 6) over a 30-year period was estimated to be $85,900,000 in capital cost and $20,000,000 in operating and maintenance cost, corresponding to a total 30-year cost of $105,900,000. Operating and maintenance costs include operation and maintenance of the OSDF and its associated leachate collection and treatment system, groundwater monitoring, and CERCLA five year reviews.

The cost of off-site disposal of the low-level radioactive waste from OU2 (Alternative 3) was estimated to be $212,800,000, including $200,200,000 in capital cost and $12,600,000 in operating and maintenance cost.[17] Operating and maintenance costs for Alternative 3 include limited groundwater monitoring and CERCLA five year reviews at the OU2 site to ensure that the waste removal action for the remedial alternative remains effective. There are no operating and maintenance costs associated with the commercial off-site disposal facility. It is assumed that the DOE pays a one time fee to the commercial facility for disposal of the OU2 waste, which is considered a capital cost. There would be operating and maintenance costs associated with off-site disposal of the OU2 waste at the Nevada Test Site. However, DOE estimated that off-site disposal of the OU2 waste at the Nevada Test Site is a more costly alternative than off-site disposal at a commercial facility, and therefore assumed for the purposes of the Alternative 3 cost estimate that a commercial disposal facility would be used. A detailed breakdown of the capital and operating and maintenance costs for off-site disposal at the Nevada Test Site was not available for review for this study.

State Acceptance and Community Acceptance

In the ROD, there is a discussion of the need for DOE to take a “balanced approach to waste management.” This balanced approach means splitting up the burden of waste disposal among sites and States by keeping some of the Fernald-generated waste on-site and shipping some of the waste off-site. This approach appears to have been established based on DOE’s perception of the need to gain concurrence of the Governors of Utah and Nevada as well as the Ohio Environmental Protection Agency for DOE’s decision to dispose of Fernald-generated waste in existing disposal facilities in these states. According to the ROD, this balanced approach was endorsed by the State of Nevada Division of Environmental Quality, the State of Utah Department of Environmental Quality, as well as stakeholders in Nevada. The ROD also stated that although some stakeholders categorically rejected DOE’s decision to dispose of low-level radioactive waste at the Fernald site, other stakeholders in Ohio understood “the necessity of taking a balanced approach” to DOE waste management. Judging from the statements and discussion in the ROD, it appears that state and community acceptance criteria and the “balanced approach to waste management” were strongly considered in the decision-making process, and may have ultimately been the difference between DOE selecting on-site vs. off-site disposal for the Fernald waste generated from OU2.

IMPLICATIONS OF DECISION WITH REGARD TO LONG-TERM STEWARDSHIP

The decision to construct the OSDF resulted in new long-term stewardship obligations for DOE. In accordance with the alternative as described in the Feasibility Study and the ROD, new engineered structures are being constructed and operated at the FEMP, including:[18,19]

- A 300,000 square foot multi-layer cap made of clay, gravel, and plastic;
- A 300,000 square foot liner system made of clay, gravel, and plastic;
- A leachate collection system located under 65 feet of radioactive waste;
- A leak detection system; and
- A groundwater monitoring system

As described in the 1999 *Environmental Assessment for Proposed Land Use at the Fernald Environmental Management Project*[20] and the *Finding of No Significant Impact* for the Environmental Assessment [21], the OSDF and the Fernald site will require various restrictions and commitments, including:

- The final remediation levels for the site will not allow unrestricted use;
- The FEMP will remain under federal ownership;
- Institutional controls will be required at the site;
- The OSDF will need to be maintained and monitored by DOE in perpetuity;
- Ecological restoration will be conducted for the major portion of the site; and
- Public access and recreation are anticipated for at least some portion of the site

The specific institutional controls and maintenance requirements for the OSDF are identified in the Record of Decision:[22]

- Access restrictions (i.e., fencing);
- Groundwater monitoring;
- General site monitoring for at least 30 years;
- Land use restrictions (federal ownership);
- Maintenance of the OSDF;
- Maintenance of the capping system;
- Maintenance of the leachate collection system; and
- CERCLA five year reviews

As a result of the decision to build the OSDF, long-term stewardship obligations for DOE were created at the FEMP that could have otherwise been minimized or avoided had DOE selected a different alternative. If the OU2 waste were to have been disposed of at an existing commercial low-level waste disposal facility (Alternative 3), DOE would have reduced, and perhaps eliminated long-term stewardship obligations for the OU2 waste, as these obligations would become the responsibility of the commercial disposal firm in accordance with their NRC license to operate the disposal facility.[1] DOE would have been required to continue to conduct limited groundwater monitoring and CERCLA five year reviews at the OU2 site to determine that the waste removal remedy remained effective. However, as the OU2 waste would have been removed from the FEMP site under Alternative 3, it would be anticipated that groundwater monitoring and CERCLA five year reviews for the OU2 site would not need to be conducted in perpetuity. At some time in the future it would be anticipated that the U.S. EPA and Ohio EPA would determine that the waste removal remedy had been effective, and would determine that groundwater monitoring and CERCLA five year reviews would no longer be required. Operating and maintenance costs for Alternative 6, for which the OU2 waste remains on-site, would be anticipated to be incurred in perpetuity, as the residual hazard of the disposed OU2 waste would remain in perpetuity.

If the OU2 waste had been disposed of at the Nevada Test Site or another DOE facility, DOE would still need to conduct long-term stewardship activities for the waste, and would still incur operating and maintenance costs for long-term stewardship. A detailed cost estimate for off-site disposal of the OU2 waste at the Nevada Test Site was not available for review for this study. However, it is anticipated that the engineered and institutional controls and associated long-term stewardship activities required for the OU2 waste would not differ significantly if the waste were to be disposed of in Utah or Nevada or in Ohio, as the characteristics of the waste are constant. The specifics of the design of the engineered and institutional controls would be site specific, however. For example, the design of the waste disposal unit would differ between Nevada or Utah and Ohio because of factors such as amount of rainfall and volume of leachate, depth to groundwater, soil types, etc. However, the ROD indicates that off-site disposal of the OU2 waste at Nevada Test Site would be more expensive than either off-site disposal of the waste at the commercial facility or on-site disposal of the waste in the OSDF. It is unclear why this would be the case, as the cost of constructing and operating and maintaining the waste disposal unit would not be expected to differ significantly among the sites. This represents an area where further research may be warranted.

CONCLUSIONS

The decision to construct and operate the OSDF at the FEMP and analysis of the decision-making criteria and methodology provide the basis for several broad conclusions concerning long-term stewardship issues.

[1] Note that this ignores the real concern of whether any private sector entity will be able to maintain the organization and resources to provide long-term stewardship of commercially disposed low-level radioactive waste in perpetuity. Although private sector entities are required to maintain financial assurance as a condition of their NRC licenses, ultimately, if a private sector entity is unable to provide long-term stewardship because of financial resource or other limitations, the Federal government may need to assert control over the disposed waste to provide long-term stewardship.

Cost

The net present worth methodology used for the cost estimates for the remedial alternatives may not provide for a truly "unbiased" comparison of the alternatives. The net present worth methodology does not fully recognize the need to conduct long-term stewardship for the OSDF in perpetuity. The OU2 wastes to be disposed of in the OSDF include uranium-238 (half-life 4.5 billion years), uranium-235 (half-life 700 million years), and thorium-230 (half-life 75,400 years).[23] The OU2 Feasibility Study explicitly acknowledges that the OSDF would be designed for a maximum operating life of 1,000 years[24] and the 1999 Land Use Environmental Assessment cites the Operating Unit 5 ROD as requiring that "DOE will monitor and maintain an On-Site Disposal Facility in perpetuity."[25] If the residual hazards will persist effectively in perpetuity, and the OSDF will require monitoring and maintenance in perpetuity, then a 30-year assessment of cost of operation and maintenance may not represent an appropriate basis for the comparison of the alternatives.

The net present worth cost estimation methodology incorporated into *DOE Guide 430.1-1* (Life Cycle Cost Estimate)[26] cannot fully account for situations where DOE is required to incur long-term stewardship costs in perpetuity. The present value of future costs is effectively zero after several decades. Therefore an alternative having lower initial construction and operating costs (e,g., Alternative 6) will almost always outweigh an alternative having higher initial costs (e.g., Alternative 3), even if the former alternative requires DOE to incur long-term stewardship costs in perpetuity and the latter alternative only requires DOE to incur long-term stewardship costs only for several decades. Therefore, DOE may want to develop an alternative means of conducting comparative cost analysis for remedial alternatives so that alternatives requiring DOE to incur long-term stewardship costs in perpetuity are evaluated on a more unbiased basis against alternatives that do not require perpetual long-term stewardship.

It also appears that the cost analysis for the alternatives does not fully reflect the cost savings that may occur from disposing of the OU2 waste at an already-functioning off-site disposal facility. DOE could have decided under Alternative 3 to dispose of the OU2 waste at an existing low-level waste disposal facility at the Nevada Test Site or another DOE facility. These DOE sites are already conducting ongoing long-term stewardship activities for low-level radioactive waste, and increasing the volume of waste disposed of at these existing facilities would be expected to represent only an incremental increase in the cost of long-term stewardship.

For the Nevada Test Site, it would be expected that many of the anticipated long-term stewardship costs, including those associated with monitoring and maintenance personnel, training, groundwater monitoring, access restrictions, and permitting, would only increase incrementally for additional waste disposed of at the existing facility. However, the cost estimate for off-site disposal of the OU2 waste at the Nevada Test Site does not reflect this expectation. The estimated cost of off-site disposal of the OU2 waste at Nevada Test Site is higher than either off-site disposal at a commercial facility or on-site disposal in the OSDF. As noted above, additional research is needed to more fully understand the basis for this estimate.

It may be advantageous from both a cost and organizational standpoint for DOE to consolidate its long-term stewardship activities at a smaller number of locations. Looking only at the OU2 waste, DOE must maintain two local organizations to conduct long-term stewardship in perpetuity, one in Ohio for the OSDF, and one in Nevada for the Nevada Test Site waste disposal areas. In contrast, if the OU2 waste had been disposed of at Nevada Test Site, DOE would have to maintain only a single local organization in a single location to perform long-term stewardship activities for the OU2 waste.

State and Community Acceptance

DOE's policy of taking a "balanced approach to waste management," and splitting up the burden of waste disposal among sites and states, was an important factor in the *State and Community Acceptance* Criteria. If applied throughout the DOE complex, this approach could result in DOE having to conduct long-term stewardship activities in perpetuity at dozens of locations, whereas from an economic and technical feasibility standpoint DOE could consolidate its long-term stewardship obligations at relatively few sites and remediate other sites to conditions appropriate for economic reuse, ecological restoration, or unrestricted use, thereby minimizing DOE's long-term stewardship activities and costs. Otherwise, DOE or a successor agency will need to maintain in perpetuity dozens of local organizations to conduct long-term stewardship activities, duplicating efforts that could have been consolidated at relatively few locations and incurring future long-term stewardship costs that need not be incurred.

Any consolidation of DOE's long-term stewardship activities and costs among fewer DOE sites would involve a transfer of risk from one location to another, and such transfer may not appear to be equitable to all affected parties. From an equity perspective it is desirable for diverse locations to bear a portion of the overall risk from DOE's legacy waste, rather than for DOE to concentrate the risk in a relatively few locations. Equity is an important consideration for state and community acceptance of remedial alternatives, as indicated by the discussion of this issue in the OSDF ROD. Conversely, DOE may not be minimizing the *aggregate* risk from its legacy waste by implementing a 'balanced approach". Specifically, the OSDF is situated above a sole source drinking water aquifer, and there is a low but finite probability that over the course of time failure of engineered controls for the OSDF could result in contamination of the aquifer. The alternative off-site disposal facilities in Utah and Nevada are not located in the vicinity of drinking water aquifers, so, other factors being equal, there is potentially a lower probability that failure of engineered controls would result in contamination of drinking water aquifers and subsequent human exposure if the OU2 waste were to be disposed of in Utah or Nevada. Therefore, in an effort to balance decision criteria, including cost, long term effectiveness and permanence, and state and community acceptance, DOE may be accepting a higher risk that the construction and operation of the waste disposal unit will contaminate a drinking water aquifer.

Long-term Effectiveness and Permanence

The ROD concluded that Alternative 6 (*Excavation and On-site Disposal)* does not offer as high a degree of long-term effectiveness and permanence as Alternative 1c (*Excavation and Off-site Disposal*), but also concluded that the selected remedy would significantly reduce the risks from the contaminated material through excavation and placement in an engineered on-site disposal facility. However, over the time frame of the residual hazard of the OU2 waste, the restrictions and commitments associated with the decision to construct the OSDF may create an increased potential for exposure of the public and the environment as opposed to a decision to dispose of the OU2 waste off-site. Perpetual maintenance and monitoring of the engineered controls will be required to ensure that the Great Miami Aquifer (a high-yield sole-source aquifer) and adjacent ecologically restored areas of the site, do not become contaminated, and maintenance of institutional controls will be required to ensure that human intrusion from areas of the site that are open to public access does not occur. This is in contrast to Alternative 1c, which would have involved the transfer and disposal of the waste off-site to a facility in a remote, arid area with naturally poor groundwater and low-permeability soil.[27]

DOE modeled the performance of the OSDF over a period of 1,000 years assuming that "man-made" components of the OSDF (e.g., the liner and leachate collection system) fail, but that other engineered control components of the OSDF including the clay cap retain their integrity over this period of time. DOE estimated based on the modeling results that operation of the OSDF over a 1,000 year period would not result in contamination of the groundwater aquifer to levels exceeding MCLs. There is no indication in the ROD as to what effect the modeling assumptions had on the modeling results or whether an analysis of a complete failure of the OSDF engineered controls has been conducted elsewhere. However, the assumption that the clay cap retains its integrity over a 1,000 year period may not be appropriate for consideration of long-term stewardship issues. The integrity of the cap may depend upon the continued maintenance of site access restrictions and other institutional controls that may not be expected to persist over a 1,000 year period, and the assumption that the OSDF cap material would retain its integrity over a 1,000 year period may not be conservative. Although the Ohio EPA and U.S. EPA concluded that construction of the OSDF would be protective, DOE has not demonstrated from a long-term stewardship perspective that engineered and institutional controls can be maintained such that the aquifer is protected over the time frame of the residual hazard of the OU2 waste.

It is notable that the ROD only discusses failure modes and consequences for disposal of the OU2 waste at the OSDF, and not for off-site disposal of the waste at the Clive, Utah site or Nevada Test Site. The ROD concluded that off-site disposal of the OU2 waste would provide the most effective long-term protection of human health and the environment *in Ohio*, but apparently without considering the fact that a substantial portion of the risk would be transferred from Ohio (and its local receptors) to Utah or Nevada (and their local receptors) if the waste is disposed of off-site. This analysis may have been conducted elsewhere, but does not appear to have been considered in the selection of the Alternative. Therefore, with respect to the decision-making process, there is no means to determine whether DOE has minimized the *aggregate* risk associated with the OU2 waste through the selection of Alternative 6, on-site disposal. Waste disposed of off-site appears to zero out of the risk analysis for the remedial alternatives, and the aggregate risk associated with each alternative does not appear to be considered.

As discussed above, there are several factors related to risk that differ significantly between the FEMP and Nevada Test Site and Clive, Utah, most notably the location of a sole source drinking water aquifer in the vicinity of the OSDF. There is effectively no risk that a sole-source aquifer would be contaminated in the event of a failure of the engineered control system if the waste were disposed of at Clive Utah or at Nevada Test Site, while some finite risk of contamination of a sole source aquifer exists for the OSDF. However, there may be other characteristics of the

Nevada Test Site or Clive site that would increase the aggregate risk as compared to the OSDF. DOE should therefore consider conducting a *comparative* risk analysis with respect to long-term stewardship when evaluating remedial alternatives, rather than effectively assuming disposal of waste at an off-site DOE or commercial facility eliminates the risk associated with the waste.

ENDNOTES

1. *Final Record of Decision for Remedial Actions at Operable Unit 2*, Fernald Environmental Management Project, U.S. Department of Energy. Fernald, Ohio. May 15, 1995.

2. *Finding of No Significant Impact for the Fernald Environmental Management Project Proposed Final Land Use Environmental Assessment*, FONSI (DOE/EA-1273), April 20, 1999, Page 3.

3. *Final Record of Decision for Remedial Actions at Operable Unit 2*, Fernald Environmental Management Project, U.S. Department of Energy. Fernald, Ohio. May 15, 1995. Pg.9-2.

4. *Final Record of Decision for Remedial Actions at Operable Unit 2*, Fernald Environmental Management Project, U.S. Department of Energy. Fernald, Ohio. May 15, 1995. Pg.8-10.

5. *Final Record of Decision for Remedial Actions at Operable Unit 2*, Fernald Environmental Management Project, U.S. Department of Energy. Fernald, Ohio. May 15, 1995. Pg.D-1.

6. *Final Record of Decision for Remedial Actions at Operable Unit 2*, Fernald Environmental Management Project, U.S. Department of Energy. Fernald, Ohio. May 15, 1995. Ch.7.

7. *Final Record of Decision for Remedial Actions at Operable Unit 2*, Fernald Environmental Management Project, U.S. Department of Energy. Fernald, Ohio. May 15, 1995. Page 8-9.

8. *Final Record of Decision for Remedial Actions at Operable Unit 2*, Fernald Environmental Management Project, U.S. Department of Energy. Fernald, Ohio. May 15, 1995. Page 8-1.

9. *Final Record of Decision for Remedial Actions at Operable Unit 2*, Fernald Environmental Management Project, U.S. Department of Energy. Fernald, Ohio. May 15, 1995. Page 8-1.

10. *Final Record of Decision for Remedial Actions at Operable Unit 2,* Fernald Environmental Management Project, U.S. Department of Energy. Fernald, Ohio. May 15, 1995. Page 10-4.

11. *Final Record of Decision for Remedial Actions at Operable Unit 2*, Fernald Environmental Management Project, U.S. Department of Energy. Fernald, Ohio. May 15, 1995. Page 10-7.

12. *Final Record of Decision for Remedial Actions at Operable Unit 2*, Fernald Environmental Management Project, U.S. Department of Energy. Fernald, Ohio. May 15, 1995. Page 10-9.

13. *Final Record of Decision for Remedial Actions at Operable Unit 2*, Fernald Environmental Management Project, U.S. Department of Energy. Fernald, Ohio. May 15, 1995, Page 8-5.

14. *Final Record of Decision for Remedial Actions at Operable Unit 2*, Fernald Environmental Management Project, U.S. Department of Energy. Fernald, Ohio. May 15, 1995. Page 8-10.

15. *Feasibility Study Report for Operable Unit 2*, Fernald Environmental Management Project, U.S. Department of Energy. Fernald, Ohio. March, 1999. Page 5-123.

16. *Final Record of Decision for Remedial Actions at Operable Unit 2*, Fernald Environmental Management Project, U.S. Department of Energy. Fernald, Ohio. May 15, 1995, Page 8-10.

17. *Feasibility Study Report for Operable Unit 2*, Fernald Environmental Management Project, U.S. Department of Energy. Fernald, Ohio. March, 1999. Pp.5-123, 5-84.

18. www.fernald.gov. Last visited on September 22, 2000.

19. *Feasibility Study Report for Operable Unit 2*, Fernald Environmental Management Project, U.S. Department of Energy. Fernald, Ohio. March, 1999. Page 5-99.

20. *Environmental Assessment for Proposed Land Use at the Fernald Environmental Management Projec*t, Fernald Environmental Management Project, U.S. Department of Energy. Fernald, Ohio. June, 1999. Page 2.

21. *Finding of No Significant Impact for the Fernald Environmental Management Project Proposed Final Land Use Environmental Assessment*, FONSI (DOE/EA-1273), April 20, 1999. Page 3.

22. *Final Record of Decision for Remedial Actions at Operable Unit 2*, Fernald Environmental Management Project, U.S. Department of Energy. Fernald, Ohio. May 15, 1995. Page 9-2.

23. *Final Record of Decision for Remedial Actions at Operable Unit 2*, Fernald Environmental Management Project, U.S. Department of Energy. Fernald, Ohio. May 15, 1995. Table 6-1.

24. *Feasibility Study Report for Operable Unit 2*, Fernald Environmental Management Project, U.S. Department of Energy. Fernald, Ohio. March, 1999. Page 5-103.

25. *Environmental Assessment for Proposed Land Use at the Fernald Environmental Management Projec*t, Fernald Environmental Management Project, U.S. Department of Energy. Fernald, Ohio. June, 1999. Page 2.

26. DOE Order 430.1A, *Life Cycle Asset Management*. Approved 10-14-98; DOE Guide 430.1-1, Chapter 23, *Life Cycle Cost Estimate*.

27. www.envirocareutah.com. Envirocare Website for the Clive, Utah Disposal Facility. Last visited on September 25, 2000.

APPENDIX B

INEEL TEST AREA NORTH REMEDIATION

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INEEL TEST AREA NORTH REMEDIATION

INTRODUCTION

The Idaho National Engineering and Environmental Laboratory (INEEL) is a U.S. Department of Energy (DOE) facility located in southeastern Idaho, 30 miles west of Idaho Falls,[1] which has a population of approximately 50,000[2]. The site occupies approximately 890 square miles of the northeastern portion of the Eastern Snake River Plain. Test Area North (TAN) is located in the north portion of the site and occupies 0.16 square miles of the INEEL. The Eastern Snake River Plain stands above the Snake River Plain Aquifer (SRPA), the largest potable aquifer in Idaho. Approximately 9 percent of the aquifer lies beneath INEEL, including portions of TAN. The depth to groundwater at INEEL is the shallowest at TAN (approximately 61 m or 200 ft), and greatest on the southwest edge of INEEL (approximately 274 m or 900 ft).

INEEL was established in 1949 as the National Reactor Testing Station by the U.S. Atomic Energy Commission for nuclear energy research and related activities. Between 1954 and 1961, TAN was used to test the concept of nuclear-powered airplanes. Between 1962 and 1979, TAN was used to perform reactor safety testing and behavior studies. The area remained active in the 1980s, conducting work with material from the 1979 Three Mile Island reactor accident. Parts of TAN are still in use for activities such as manufacturing armor for military vehicles and nuclear inspection and storage.

DESCRIPTION OF PROJECT

Test Area North is one of ten waste area groups (WAGs) at the INEEL that are undergoing cleanup. There have been 94 potential release sites studied at TAN. Of these 94 sites:[3, 4]

1. Seventy-six release sites were determined “not to pose an immediate and substantial endangerment to human health and the environment,” and were classified as “No Action”. The “No Action” designation means that residential, occupational, and future residential risks are all less than or equal to 0.0001 (the acceptable risk levels); therefore, institutional controls are not required, and the site is suitable for unrestricted land use.[1]

2. Seven release sites were determined “not to pose an immediate and substantial endangerment to human health and the environment,” and were classified as “No Further Action”. The “No Further Action” designation means that current occupational and future residential risks are less than 0.0001 (the acceptable levels), but the current residential risk is greater than 0.0001; therefore, institutional controls are required for at least 100 years or until the site is released for unrestricted use in a 5-year review.

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[1] Site remediation goals for TAN are based on soil concentrations equivalent to a risk of 1 E-04 to a hypothetical resident living on the site 100 years in the future. Risk to a hypothetical resident living on the site at the present time and occupational exposure risk to workers on-site at the present time were also evaluated for “No Action” and “no further action” sites.

3. Two release sites are currently undergoing cleanup and are on track to meet remedial action objectives;

4. One release site was evaluated as part of another INEEL waste area group; and

5. Eight release sites were evaluated in the *Remedial Investigation/Feasibility Study for Test Area North Operable Unit 1-10*, DOE/ID-10557 (RI/FS), and had remedial actions decided on in the *Final Record of Decision for Test Area North*, DOE/ID-10682.

The eight sites evaluated in the Remedial Investigation/Feasibility Study (RI/FS) and the Record of Decision (ROD) are the primary subject of this case study. These sites were grouped by INEEL according to the similarity of the problem, and/or their proximity to one another[5]:

1. **V-Tanks** (sites TSF-09 and TSF-18). These sites consist of large, abandoned underground storage tanks that contain liquid and sludge, and the contaminated soil surrounding the tanks. The contaminant of concern is cesium-137, but organic compounds and heavy metals are also present.

2. **PM-2A Tanks** (site TSF-26). This site contains two large, waste-containing underground storage tanks and the contaminated surface soil around them. The contaminant of concern is cesium-137, but organic compounds and heavy metals are also present.

3. **Soil Contamination Area South of the Turntable** (site TSF-06). This site is an open area containing contaminated surface soil. The contaminant of concern is cesium-137.

4. **Disposal Pond** (site TSF-07). This site contains an unlined disposal pond that had historically received low-level radioactive waste. The contaminant of concern is cesium-137, but within 100 years the cesium is expected to decay to levels that would allow unrestricted land use.

5. **Burn Pits** (sites TSF-03 and WRRTF-01). These sites were used for open burning of construction debris roughly 25-50 years ago. The contaminant of concern is lead. There is no radionuclide contamination on the site.

6. **Fuel Leak** (site WRRTF-13). This site contains soil that is contaminated by diesel fuel and heating oil that leaked from the tanks and pipes that were previously located on the site. The contaminants of concern are oils and diesel fuel. There is no radionuclide contamination on this site.

ALTERNATIVES CONSIDERED

In October, 1999, DOE issued a *Final Record of Decision for Test Area North, Operable Units 1-10* at the Idaho National Engineering and Environmental Laboratory. The Record of Decision presented the remedial action alternatives that were considered for the six major site groups listed above, the criteria upon which they were evaluated, and the remedy selected to be carried out at each site group. The remedial alternatives for each site group were analyzed individually, and then compared according to the nine CERCLA remedy evaluation criteria.

Table 1 identifies the selected remedy for each site group, with a brief discussion of the long-term stewardship activities associated with it, and the other alternatives that were evaluated in the ROD. Some alternatives that were initially identified but not further analyzed in the RI/FS or ROD (e.g., No Action alternatives) are not included in the table.

DECISION-MAKING CRITERIA

Nine criteria were used to evaluate the alternatives.[6] These criteria are consistent with the requirements set forth under CERCLA for evaluating and selecting remedies.

1. *Overall Protection of Human Health and the Environment* – addresses whether or not a remedy provides adequate protection to human health and the environment, and describes how risks posed through each pathway are eliminated, reduced, or controlled.

2. *Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)* – addresses whether or not a remedy will meet all of the ARARs of other Federal or State environmental statutes and/or provide grounds for invoking a waiver.

3. *Long-Term Effectiveness and Permanence* – refers to the two criteria: magnitude of residual risk remaining at the conclusion of the remedial activities; and the adequacy and reliability of controls (e.g., containment systems and institutional controls)

4. *Reduction of Toxicity, Mobility, or Volume through Treatment* – the anticipated performance of the treatment technologies that may be employed in a remedy.

5. *Short-Term Effectiveness* – refers to the following criteria: short-term risks to the community; potential impacts to workers during remedial action; effectiveness and reliability of protective measures; potential environmental impacts; and time until protection is achieved

6. *Implementability* – the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement the chosen solution.

7. *Cost* – includes the costs for cleanup, remedial design and remedial action, construction, operations, and surveillance and monitoring. Net present value analysis was used to compare the cost of each alternative.

TABLE 1: Test Area North Site Group Alternatives and Selected Remedies		
Site Area[7]	**Selected Remedy and Associated Activities**	**Other Alternatives Considered**
V-Tanks	*#2. Soil and tank removal, ex-situ treatment of tank contents, and disposal:* Soil will be excavated, and tank contents will be removed. Tank contents will undergo off-site ex-situ treatment to remove organic compounds and/or heavy metals. Soil will be disposed of at an "acceptable soil repository" either on-site or off-site. Tanks will be decontaminated, excavated, and disposed of, and tank contents will be disposed of at an off-site disposal facility.	#3. Soil excavation and disposal, in-situ stabilization of tank contents; #4. In-situ vitrification of the tanks, their contents, and surrounding soil
PM-2A Tanks	*#3. Soil excavation, tank content vacuum removal, treatment, and disposal:* Soil will be excavated and tank contents will be removed via vacuum. If the waste does not meet the waste acceptance criteria of the disposal facility, the material will undergo treatment to remove organic compounds and/or heavy metals. Soil and tank contents will be disposed of at "an acceptable soil repository" either on-site or off-site. Tanks will be decontaminated and backfilled, and will remain in place. The tanks may be removed in the future.	#2. Excavation, ex-situ stabilization, disposal of soil and tank contents #4. Soil excavation and disposal, in-situ stabilization of tank contents #5. Soil excavation and disposal, in-situ vitrification of tank contents
Soil Contamination Area	*#3. Excavation and on-site disposal:* Soil will be excavated and disposed of on the INEEL approved soil repository. At the time of the decision, it was undetermined where on the INEEL the soil repository would be located.	#2. Containment - native soil cover or engineered barrier
Disposal Pond	*#1. Limited Action:* Existing management practices will continue, including institutional controls and environmental monitoring, until contamination decays to levels that allow unrestricted land use.	#2. Containment - native soil cover or engineered barrier #3. Excavation and disposal
Burn Pits	*#2. Native Soil Cover*: A layer of clean soil and surface vegetation or rock would be added to cover the contaminated soil at the burn pits.	#1. Limited action - continue existing management practices #3. Excavation and soil cover #4. Excavation and soil washing
Fuel Leaks	*#4. Excavation and Land Farming:* Contaminated soil would be excavated, and removed to INEEL's Central Facilities Area Land Farm. The contaminated soil would be mixed with other soil that stimulates the growth of microbes to break down contaminants.	#1. Limited action - continue existing management practices #2. Containment - native soil cover #5. In-situ biodegradation using bioventing

8. *State Acceptance* – indicates whether, based on its review of planning and decision documents, the State concurs with, opposes, or has no comment on the preferred remedial alternative.

9. *Community Acceptance* – includes determining which components of the alternatives are supported, questioned, or opposed by interested persons in the community.

The first two criteria are defined by CERCLA as threshold criteria, meaning they must be satisfied in order for an alternative to be considered as the selected remedial alternative. Criteria Nos. three through seven are defined as primary balancing criteria, meaning that these criteria are used to weigh the alternatives. Criteria Nos. eight and nine are defined as modifying criteria, which means they are taken into account after public comment is received on the Proposed Plan.

CONSIDERATION OF LONG-TERM STEWARDSHIP IN DECISION-MAKING

As demonstrated in the Feasibility Study and the Record of Decision, the criteria that were used to evaluate the remedial alternatives did consider long-term stewardship needs and costs. The criteria *long-term effectiveness and permanence, reduction of toxicity, mobility, and volume through treatment*, *implementability*, and *cost* most clearly addressed aspects of long-term stewardship, including engineered and institutional controls, re-remediation, and life-cycle costs.

Institutional Controls

As a component of the *long-term effectiveness and permanence* criterion, alternatives were evaluated according to the "adequacy and reliability of controls such as institutional controls.[8]" The *implementability* criterion included an evaluation of "ability to monitor the effectiveness of the remedy[9]", and refers to activities such as groundwater monitoring and other environmental monitoring. The remedy selection process for TAN indicates that the needs and costs for institutional controls for each alternative were considered in the decision-making process.

1. The remedies selected for the V-Tanks, PM-2A Tanks, Soil Contamination Area, and Fuel Leak area all avoid relying on long-term institutional controls to provide protection of human health and the environment at TAN. After remediation is complete, the levels of contamination remaining at the V-Tanks, PM-2A Tanks, and Soil Contamination Area are expected to be appropriate to allow release of the sites for unrestricted use. Excavated wastes will be transferred from these sites to other on-site or off-site waste treatment and disposal sites that will require long-term stewardship. Surveillance and monitoring of the V-Tanks and PM-2A Tanks and Soil Contamination Area will be required to demonstrate that the waste excavations have been effective, and institutional controls may be required for the V-Tanks and PM-2A Tanks and Soil Contamination Area depending upon the results of post-remediation sampling. Any institutional controls for the V-Tanks and PM-2A Tanks and Soil Contamination Area are not anticipated to be needed for more than a 100 year period after remediation is completed.

2. Institutional controls will be relied upon for the remedy for the Disposal Pond Area , but institutional controls are only expected to be necessary for 100 years, by which time the concentrations of the contaminant of concern (cesium-137) are expected to be reduced by natural decay to levels appropriate to allow the site to be released for unrestricted use.[10]

3. The selected remedy for the Burn Pits will require the use of and dependence on institutional controls in perpetuity.

Therefore, four of the six areas for which remedies were selected in the ROD are not anticipated to require long-term stewardship after remediation is completed (subject to the results of post-remediation surveillance and monitoring), and a fifth area is anticipated to require institutional controls for only 100 years after remediation is completed. Alternatives that were considered and not selected for these four areas would have required institutional controls in perpetuity. Remedies for the four areas involve excavation and removal of waste to either on-site or off-site waste treatment or disposal facilities. Waste removal, treatment, and disposal consolidates the needs and costs of engineered and institutional controls, and utilizes long-term stewardship tools and resources (e.g., groundwater monitoring wells, site workers, signs, fences) more efficiently than having waste disposed of at numerous locations at TAN. Of the 94 sites at TAN, seven "no further action" sites and three additional sites were identified as needing institutional controls, including access restrictions and signs. Contaminants of potential concern vary among these sites, but include radionuclides (Sr-90, tritium, Cs-137, U-234), chlorinated organic compounds, metals, and asbestos.[11] Some of these sites will undergo remediation activities as a result of decisions made at other parts of TAN, but at most of the 10 sites radionuclide contaminants will simply undergo natural radioactive decay. Institutional controls (e.g., monitoring of soil, air, and groundwater, access restrictions) needed for these sites are expected to remain in place for at least 100 years or until the site is released for unrestricted use in a 5-year review.

Engineered Controls

According to the *long-term effectiveness and permanence* criterion, alternatives are to be evaluated by the "adequacy and reliability of controls such as containment systems, ... the potential need to replace technical components of the alternative, such as a cap, slurry wall, or treatment system; and the potential exposure pathways and risks posed should the remedial action need replacement."[12]

The remedy selection process indicates that this criterion was considered in the decision-making process, and that DOE considered the needs and costs of engineered controls in selecting the remedies. However, not all long-term stewardship activities associated with the remedial alternatives were evaluated in the decision-making process. Decisions to remove contaminants of concern from the V-Tanks, PM-2A Tanks, Soil Contamination Area, and Fuel Leak Area eliminated the need for construction and operation of engineered controls at TAN, because the contaminants would be moved to already-operating on-site or off-site waste disposal facilities. In Appendix J of the Feasibility Study, which addresses cost estimate assumptions and methods, it is assumed that disposal of radioactive contaminated soils will take place at the Envirocare facility in Clive, Utah, and that off-site disposal of non-radioactive hazardous soils will take place at a facility in Arlington, Oregon.[13] Transportation of the radioactive and hazardous wastes to these facilities and commercial disposal fees are included in capital cost estimates for the remedial alternatives. However, long-term stewardship needs and costs that might be created at the off-site waste disposal facilities are not evaluated in the feasibility study. The incremental costs for long-term stewardship activities at the off-site waste disposal facilities is likely to be low, because these facilities are already in operation and long-term stewardship activities are already being conducted. Adding additional wastes to these existing sites is anticipated to result in only a small incremental cost for long-term stewardship activities.[2]

In Appendix J of the feasibility study, it was assumed that the on-site soil repository would be utilized for waste disposal for all on-site disposal alternatives. However, the cost estimates for on-site disposal did not evaluate the long-term stewardship needs and costs associated with the operation and maintenance of on-site waste disposal facilities. The Feasibility Study states: "It is assumed that the [soil] repository will be independently funded. No costs have been included for acceptance fees, or operations and maintenance or facility oversight of the disposal sites." There is no discussion in the feasibility study as to whether costs for operation of the on-site soil repository would be increased because of the waste being disposed of from TAN remediation.[14] Therefore, it is not clear whether the on-site soil disposal creates new long-term stewardship needs and costs or only consolidates existing long-term stewardship needs and costs at a single location. However, it is anticipated that adding additional excavated and treated waste from the TAN sites to an existing on-site soil remediation facility would result in only a small incremental cost for long-term stewardship activities.

One decision that did create additional engineered control requirements was for the Burn Pits; the decision to cap the contaminants with native soil relies on an engineered control that will require long-term surveillance and maintenance and is likely to ultimately require replacement. The contaminant of concern at the Burn Pits is lead, which will not decay. Remedies selected for other TAN sites (e.g., excavation, treatment, and on-site or off-site waste disposal) consolidate long-term stewardship needs and costs at existing on-site or off-site facilities, and will eliminate the need for long-term stewardship at the TAN sites. Excavation and disposal of the lead-contaminated waste from the Burn Pits would have eliminated the need for engineered controls, and moved the lead waste to an existing on-site or off-site disposal facility where long-term stewardship activities are already being conducted and are expected to continue indefinitely.

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[2] Note that off-site disposal of DOE low-level radioactive waste or hazardous wastes does not necessarily eliminate long-term stewardship needs and costs for the Department. The evaluation of off-site commercial disposal as having zero long-term stewardship cost to DOE ignores the real concern of whether any private sector entity will be able to maintain the organization and resources to provide long-term stewardship of commercially disposed low-level radioactive or hazardous waste in perpetuity. Although private sector entities are required to maintain financial assurance as a condition of their NRC licenses or EPA permits, ultimately, if a private sector entity is unable to provide long-term stewardship because of financial resource or other limitations, the Federal government may need to assert control over the disposed waste to provide long-term stewardship.

Implementability

If engineered or institutional controls fail to remain protective, long-term stewardship activities may include additional remediation - refurbishment or replacement of engineered controls or additional waste treatment or removal activities. The ability to easily remediate sites again in the future will depend upon several factors, and some of these factors were considered in the decision-making process. The *reduction of toxicity, mobility, or volume through treatment* criterion included an assessment of the "degree to which the treatment is irreversible." This assessment evaluated the expected success of any treatments (e.g., vitrification, thermal treatment), and the possibility that re-remediation would be needed. The *implementability* criterion included evaluation of "the ease of undertaking additional remedial actions.[15]"

These criteria indicate that the decision-makers recognize that hazards will remain in place for a long time, and remedial alternatives that don't remove or treat the hazards will ultimately fail, requiring additional remedial actions. Four of the six selected remedies in the ROD are not anticipated to require any on-site remediation, because the waste will be excavated, treated and removed from TAN. By removing the waste from TAN, any risks associated with remedy failure are also effectively removed from TAN. However, as discussed above, long-term stewardship needs and costs that may be associated with either on-site or off-site disposal of wastes generated from TAN remediation are not identified or discussed in the feasibility study. Two remedies involve leaving wastes on-site. For the disposal pond, the residual hazards were small enough and the lifetime of the residual hazards short enough to justify selection of natural attenuation as the remedial alternative. For the Burn Pits, on-site capping of the waste was selected based on the relative level of hazard of the waste and the cost of other alternatives.

Re-remediation is anticipated to be necessary for the on-site or off-site disposal facilities at which the waste excavated from the TAN sites will be disposed. The feasibility study and other decision documents do not identify or evaluate the probability or consequences of failures of on-site or off-site disposal facilities, as such failures will not directly affect TAN. It is anticipated, however, that risks and costs associated with operation and potential failure of the on-site and off-site disposal facilities are discussed in other decision documents. The decision to excavate waste from the TAN areas consolidates the remediation wastes at a small number of disposal facilities, while other remedial alternatives would have resulted in waste being disposed of at several locations at TAN. Consolidation of wastes at fewer locations makes it easier for site stewards to conduct long-term stewardship activities and is anticipated to reduce long-term stewardship needs and costs as compared with other alternatives.

As discussed above, the remedy selected for the Burn Pits involves capping of lead-contaminated soil at the Burn Pits. This decision is being reevaluated based on community concerns. DOE has indicated that the Burn Pits will be reinvestigated and that DOE would reconsider the decision to cap the lead-contaminated waste in place if constituents other than lead are found to be of concern. DOE had previously concluded based on risk analysis that lead concentrations in the soil were low enough such that capping in place and institutional controls would constitute a protective remedy. However, the ongoing reevaluation of the Burn Pits remedy is an indication that the selected remedy must be considered an interim remedy rather than a permanent remedy.

In the event that DOE deems the selected remedy for the Burn Pits to be a permanent remedy, the cap will require surveillance and maintenance and ultimate refurbishment or replacement.

Cost

The *cost* estimation methodology included post-remediation long-term stewardship activities including "operations", and " surveillance and monitoring costs.[16]" In the feasibility study, any post-closure costs (e.g., operation, maintenance, monitoring, 5-year reviews) were accounted for a 100-year period. Costs were accounted using the net present value cost estimation method, which gives more significance to capital costs and short-term operation and surveillance and maintenance costs, and reduces the significance of longer-term costs.

Using a 100-year time frame for cost comparisons was appropriate for most of the selected remedies, because long-term stewardship activities other than record-keeping are not anticipated to be required for more than 100 years for any of the selected remedies except for that for the Burn Pits, for which long-term stewardship is anticipated to be needed in perpetuity. For the V-Tanks, PM-2A Tanks, and Fuel Leak Area, wastes will be excavated and treated and disposed of outside of TAN.

Cost estimates in the feasibility study also included costs for surveillance and monitoring of the TAN site areas even after the waste is excavated and removed. These long-term stewardship activities are considered necessary to ensure that remedial action was effective. Cost estimates assumed that these activities would need to be carried out for 100 years, but it is likely that this is an overestimation. Once surveillance and monitoring of the site verifies that contamination levels are at or below levels allowable for unrestricted use, the EPA and State should certify that waste removal action has been effective, and long-term stewardship activities other than record-keeping will no longer be needed.

A 100-year time frame for cost estimation is also appropriate for the Disposal Pond, because "radioactivity would decay to within acceptable levels during the 100-year period of institutional control."[17] In the case of the Burn Pits however, a 100-year time frame for the cost estimate underestimates the constant dollar cost of the remedy, because the contaminant of concern (lead) will not decay, and long-term stewardship activities will need to be conducted after 100 years.

However, the use of the net present value cost estimation method, instead of the constant dollar cost method, biases the results of the cost comparison for the remedial alternatives. For the V-Tanks, PM-2A Tanks, Soil Contamination Area, and Fuel Leak areas, the selected remedies becomes proportionately less expensive than the other alternatives using the constant dollar cost, because long-term costs associated with the alternatives are discounted in the net present value analysis but are not discounted in the constant dollar cost analysis. For the Disposal Pond, the selected remedy becomes proportionately more expensive if the constant dollar cost method is used, but even considering constant dollar costs rather than net present value costs the selected remedy is over $16 million (400 percent) less expensive than the next lowest cost alternative.

In the case of the Burn Pits, using constant dollar costs rather than net present value costs changes the results of the cost comparison of the remedial alternatives. Whereas the selected remedy (soil cover and institutional controls) costs approximately the same as the next lowest cost alternative (excavation and on-site disposal) using the net present value costs, the selected remedy becomes over $2.5 million more expensive than the next lowest cost alternative if the constant dollar costs are used[18]. Therefore, if the constant dollar cost method were the standard of comparison for the remedial alternatives analysis, a different alternative might have been selected for the Burn Pits.

Once all permits are in place and on-site or off-site disposal fees have been paid by DOE, long-term stewardship costs for the disposed waste are assumed to become the responsibility of the disposal facility operator, whether it be another operating unit of INEEL or a private entity. However, this may not be a valid assumption, particularly with respect to off-site commercial disposal. The operators of NRC-licensed or EPA-permitted waste disposal facilities are required to maintain financial assurance to fund long-term stewardship of the disposed materials after closure of their facilities. Assuming that the operators are fiscally responsible and that their estimates of long-term stewardship costs are correct, and that their business institution and their licensing institution persist over the long-term, then the up-front commercial disposal fees paid by DOE should be sufficient to cover the long-term post-closure waste management costs. However, if the waste disposal facilities operators do not manage their money correctly, or fail to account all the long-term costs of post-closure waste management, the Federal government may have to reassert control over the waste, and will begin to incur long-term stewardship costs.

IMPLICATIONS OF DECISION WITH REGARD TO LONG-TERM STEWARDSHIP

As discussed above, long-term stewardship issues were included in the decision-making process. The remedy selection process generally reflected an understanding of long-term stewardship issues, with the exception of the decision to cap waste in place for the Burn Pits, which created long-term stewardship needs and costs that need not have been created. Long-term stewardship activities could have been avoided if excavation and disposal of the Burn Pits waste was selected as the remedial alternative. For the other sites included in the ROD, maintaining the long-term effectiveness of the remedy and avoiding unnecessary long-term stewardship needs and costs for the TAN sites were important criteria in the remedy selection process. Long-term stewardship obligations that were created by the remediation decisions are described in Table 2.

Table 2: Long-term Stewardship Obligations Created by Decisions at Test Area North

Site Group	Long-Term Stewardship Obligations
V-Tanks	• Institutional controls (“signs, access control, and land-use restrictions”), to be conducted until post-remediation sampling of air, soil, and groundwater demonstrates no unacceptable risks.
PM-2A Tanks	• Institutional controls (“signs, access control, and land-use restrictions”), to be conducted until post-remediation sampling of air, soil, and groundwater demonstrates no unacceptable risks.
Soil Contamination Area South of the Turntable	• Institutional controls (“signs, access control, and land-use restrictions”), to be conducted until post-remediation sampling of air, soil, and groundwater demonstrates no unacceptable risks, and unrestricted land use is allowable (expected to be approximately 100 years).
Disposal Pond	Institutional control and monitoring activities will be conducted until the cesium-137 decays to levels that allow unrestricted land use (expected to be approximately 100 years): • Soil sampling • Inspections of groundwater monitoring wells • Access restrictions • Environmental monitoring of air, soil, and groundwater Many of these controls have already been implemented.
Burn Pits	Institutional controls and engineered controls will be relied upon indefinitely, including: • Environmental monitoring of air, soil, and groundwater • Soil cap integrity monitoring and maintenance • Access restrictions and signs
Fuel Leak	Long-term stewardship activities will not be required for the fuel leak site because contaminated soils will be removed from Test Area North, and moved to INEEL’s Central Facilities Area Land Farm.

An evaluation of how long-term stewardship issues were addressed in the decision-making process follows:

1. *V-Tanks* - the selected remedy will minimize long-term stewardship needs and costs at TAN. Long-term stewardship activities required for the V-Tanks Area will be temporary, and needed only to verify that the site is cleaned up and that the waste excavation remedy was effective. Long-term stewardship activities needed for the V-Tanks are not anticipated to be required for more than a 100 year period after remediation is completed.

2. *PM-2A Tanks* – the selected remedy will minimize long-term stewardship needs and costs at TAN. Long-term stewardship activities that are required for the PM-2A Tanks will be temporary, and needed only to verify that the site is cleaned up and that the waste excavation remedy was effective. Long-term stewardship activities needed for the PM-2A Tanks are not anticipated to be required for more than a 100 year period after remediation is completed.

3. *Soil Contamination Area South of the Turntable* – the selected remedy will minimize long-term stewardship needs and costs at TAN. Long-term stewardship activities that are required will be temporary, and needed only to verify that the site is cleaned up and that the waste excavation remedy was effective. Long-term stewardship activities needed for the Soil Contamination Area are not anticipated to be required for more than a 100 year period after remediation is completed.

4. *Disposal Pond* – the selected remedy does not eliminate needs and costs for long-term stewardship activities at TAN in the short term. According to the ROD, if Alternative 3: Excavation and Disposal of the Disposal Pond Waste was selected, "it is expected that no institutional controls would be required [at the TAN site] after the remedial action."[19] In the comparative analysis conducted as part of the Feasibility Study, excavation and disposal is described as providing "the highest degree of long-term effectiveness and permanence" over the course of the 100-year contaminant lifetime[20]. Since the perceived long-term risk of Limited Action was low, the decision was based more on minimizing short-term risk, as well as the fact that the contaminant of concern (cesium-137) is expected to decay in 100 years to concentration levels appropriate to release the site for unrestricted use. The prospect of maintaining institutional controls for a 100-year period is not unreasonable and is in accordance with regulatory requirements that do not allow DOE to assume dependence on "active" institutional controls for more than a 100-year period in conducting remedy performance assessments. The decision-makers did consider long-term stewardship and made a cost-benefit decision based on available information and considering the characteristics of the site.

5. *Burn Pits* – the selected remedy relies on long-term stewardship activities to maintain the protectiveness of the remedy, and created long-term stewardship needs and costs that need not have been created. Excavation and treatment and disposal of the contaminated soil would have minimized long-term stewardship needs and costs at TAN and improved long-term effectiveness and permanence at TAN. The remedy was selected based on the limited risk of the contaminant of concern (lead), and ease of implementation. The local community

has expressed reservations about possible risks that might remain if waste remains on-site. In response to community concerns, excavation and disposal of the Burn Pits waste may be re-considered depending on testing of contamination levels. According to the ROD, "Agencies are moving forward with a revised remedy, as a response to comments, which includes sampling that will determine if there are other constituents of concern. If so, and it is cost effective, then the contingent remedy will involve soil removal and disposal."[21] In this situation, because the waste has not been treated to reduce toxicity, the waste will require long-term stewardship wherever it is disposed of, whether it is disposed of at the Burn Pits location under an engineered cap or whether it is disposed of at an on-site or off-site engineered waste disposal unit. However, had the Burn Pits waste had been excavated and disposed of at an on-site or off-site facility, long-term stewardship needs and costs for the waste would have been consolidated at a disposal facility where such activities are already being conducted.

6. *Fuel Leak* – the selected remedy minimized long-term stewardship needs and costs. No long-term stewardship activities are expected to be required at the TAN site because the contaminants of concern (oil and diesel fuel) will be removed from the site and treated. The selected treatment technology is land farming, which will be conducted at INEEL's Central Facilities Area Land Farm. Land farming involves "mixing contaminated material with soil to stimulate growth of microbes that break down contaminants into non-toxic byproducts."[22] The remedy will remove contaminants from TAN and reduce toxicity and mobility through prolonged treatment. Once the contaminated soil is removed, monitoring will be conducted to ensure that the waste was completely removed. If the waste is not fully removed, institutional controls (e.g., monitoring, access restrictions) will be conducted until sampling demonstrates that the site is allowable for unrestricted use. Long-term stewardship activities for treated wastes at the Central Facilities Area Land Farm will be required for some unspecified duration.

In addition to the 8 sites analyzed in the ROD, there are 86 other sites at TAN. Of these 86 sites, only 10 are described by the ROD as requiring institutional controls for some duration.[23] These 10 sites are described as requiring institutional controls because they "have a current residual risk greater than .0001 [the acceptable level], but a current occupational and future residential risk less than or equal to .0001 [the acceptable levels]." Institutional controls (e.g., monitoring of soil, air, and groundwater, access restrictions,) are expected to remain in place for "at least 100 years or until the site is released for unrestricted use in a 5-year review."[24] Some of these sites will undergo some remediation activities as a result of decisions made at other parts of TAN, but most will simply undergo natural radioactive decay.

Overall, remedial decisions for the TAN sites considered in this study minimized the needs and costs for long-term stewardship at TAN and consolidated long-term stewardship needs and costs at existing facilities, with the exception of the decision to cap waste in place for the Burn Pits, which created long-term stewardship needs and costs that need not have been created. Most of the other remediation-sites at TAN were identified as "No Action" sites, meaning that these sites do not require remediation and will not require long-term stewardship. Of the 94 TAN sites, ten, in addition to the Burn Pits, are anticipated to require long-term stewardship for at least 100 years or until the sites are released for unrestricted use as a result of a five-year review. As discussed above, the net present value cost estimation method used to evaluate the remedial alternatives for the Burn Pits resulted in the selected remedy appearing to be the least-cost alternative, whereas had the constant dollar cost method been used for the cost comparison, excavation and disposal would have been shown to be the lowest cost alternative. The net present value method was also used to evaluate the seven "no further action" sites and three additional TAN sites that will require long-term stewardship. Reevaluation of these "no further action" sites using the constant dollar cost method may indicate that "no further action" and long-term stewardship is not the least cost alternative for these sites, and that alternatives that eliminate or consolidate long-term stewardship needs and costs are actually lower cost than "no further action."

ENDNOTES

1. Waste Area Group (WAG) Record of Decision, part II, p.1-1.

2. City of Idaho Falls website, www.ci.idaho-falls.id.us/index.htm?page=2. Last visited October 5, 2000.

3. Final Record of Decision for Test Area North, Ch.4.

4. Final Record of Decision for Test Area North, Ch. 12.1.

5. *Proposed Plan for Waste Area Group 1 - Test Area North*. November, 1998. Page 10-23.

6. *Comprehensive Remedial Investigation/Feasibility Study for the Test Area North Operable Unit 1-10*, Idaho National Engineering and Environmental Laboratory, U.S. Department of Energy. November, 1997. Page 12-1.

7. Final Record of Decision for Test Area North, Ch.7-9.

8. Feasibility Study, Chapter 12.1.3, pg. 12-2.

9. Feasibility Study, Chapter 12.1.6, pg. 12-8.

10. Final Record of Decision for Test Area North, Ch.7, 8, and 9.

11. Institutional Control Status Report at Test Area North, Waste Area Group 1

12. Feasibility Study, Chapter 12.1.3, pg.12-2.

13. Feasibility Study, Appendix J, pg. 3.

14. Feasibility Study, Appendix J, pg.4.

15. Feasibility Study, Chapter 12.1.4, pg. 12-7.

16. Feasibility Study, Chapter 12.1.7, pg. 12-8.

17. Final Record of Decision for Test Area North, Part II 8-13.

18. Cost comparisons were done using cost data from the Proposed Plan, as well as basic cost discounting by the author.

19. Final Record of Decision for Test Area North, Part II 8-14.

20. Feasibility Study, Chapter 12.3.3, pg. 12-29.

21. Final Record of Decision for Test Area North, Part II 9-7.

22. Proposed Plan, pg. 24.

23. Final Record of Decision for Test Area North, pg. ix.

24. Final Record of Decision for Test Area North, Part II 12-1.

APPENDIX C

MOUND SITE PROPERTY TRANSFER AND ISOTOPIC HEAT SOURCE/RADIO ISOTOPE THERMOELECTRIC GENERATOR FACILITY

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MOUND SITE PROPERTY TRANSFER AND ISOTOPIC HEAT SOURCE/RADIO ISOTOPE THERMOELECTRIC GENERATOR FACILITY

INTRODUCTION

The Miamisburg Environmental Management Project (MEMP) is located in the city of Miamisburg, Ohio, in the southwest region of Ohio, approximately ten miles southwest of Dayton, and thirty-one miles northeast of Cincinnati, Ohio. The site encompasses approximately 306 acres, divided into two industrial areas. The north area includes approximately 182 acres with about 123 structures. These structures include a significant number of laboratory, warehouse and administrative buildings, a steam generating station, and water supply and waste water treatment facilities. The site contains approximately 371,000 square feet of office space, 111,000 square feet of warehouse space, and 779,000 square feet of gross building area. The south area property includes approximately 123 acres of unimproved land with easy access to both the adjacent north area property and to state roads.[1]

The Mound Plant was established as the first permanent Atomic Energy Commission facility in support of atomic weapons research in 1948.[2] Over the years Mound became an integrated research, development and production facility. Its primary mission was process development, production engineering, manufacturing, surveillance, and evaluation of explosive components for the U.S. nuclear defense stockpile. It secondary missions included nuclear materials safeguards, radioactive waste management and recovery, building and testing of nuclear generators, and purification of radio isotopes for medical, industrial, and agricultural research.[3]

In 1989 the Department of Energy initiated a reconfiguration process that called for the eventual closing of the Mound Plant and the removal of equipment and materials to other DOE sites.[4] In November of 1989 the U.S. EPA placed Mound on the National Priorities List because of chemical contamination present in the site groundwater and the site's proximity to the Buried Valley Aquifer, a designated sole source aquifer.[5] The Department terminated Defense Program activities at the Mound Plant in 1995.

However, the Mound site continues to support the assembly and testing of Isotopic Heat Source Radio Isotope Thermoelectric Generator (HS/RTG) for the Department's Nuclear Energy Program. HS/RTGs are devices that generate heat and electricity through radioactive decay of plutonium isotopes and can be used for remote power applications including space probes.[6] DOE and its predecessor agencies have been developing HS/RTGs and supplying them to user agencies for more than 35 years.[7] The radioisotope used in these systems is plutonium-238 (Pu-238), a non-fissile form of plutonium. The HS/RTG converts thermal energy that is generated by the spontaneous radioactive decay of Pu-238 to electrical energy. The Mound Site has been performing the DOE's HS/RTG assembly test operations for over 15 years.[8]

Presently, DOE is in the process of cleaning up the Mound site, to facilitate transfer of most of the site to a non-DOE entity for economic redevelopment.[9] As part of this mission, DOE has identified the future owner and landlord of the site: the Miamisburg Mound Community Improvement Corporation (MMCIC). The MMCIC is a not-for-profit, community improvement corporation. As such, the MMCIC has been designated as an agent of the City of Miamisburg to promote economic, commercial and industrial development of the Mound site.[10]

In addition to transferring the Mound site property to the MMCIC, DOE also plans to continue operating the HS/RTG facility at the Mound site. The decision to keep the HS/RTG operation at the Mound site came after DOE had originally proposed to transfer the HS/RTG operation to a technically capable DOE site with a continuing long-term departmental presence.[11] However, after commencing an EIS and evaluating different facilities, DOE decided to keep the HS/RTG at the Mound site and preparation of the EIS was terminated.[12]

This case study analyzes the long-term stewardship implications of these two primary DOE decisions:

- The DOE program decision to privatize ownership of the Mound site and subsequent decisions by DOE to transfer individual parcels of real property by sale or lease to MMCIC; and

- The decision to keep the HS/RTG operation at the Mound site, after DOE analyzed different options to transfer the HS/RTG operation to other DOE facilities.[13]

This study includes a description of the decisions, the alternatives considered, and the decision-making criteria, and evaluates the extent to which long-term stewardship needs and costs were considered in the decision-making process. This study also identifies the implications of the decision with respect to long-term stewardship, specifically whether the decisions created additional long-term stewardship obligations for DOE.

DESCRIPTION OF PROJECT

The vision for the Miamisburg Environmental Management Project is for the Mound site to be a privately owned industrial park in the year 2005.[14] A purchase agreement with the MMCIC for sale of the Mound site to the community organization was signed in January 1998 under the authority of the Atomic Energy Act of 1954, Section 161 (g)[42 USC 22001 (g)]. As determined by DOE, USEPA, and Ohio EPA, and agreed to in the Sales Contract between DOE and MMCIC, parcels of property or "release blocks" would be remediated to "industrial use standards" before transferral to the MMCIC.[15] "Industrial land use is a category describing land used for manufacturing, processing, warehousing, packaging or treatment of products. It is the core team's [the core team is made up of DOE, EPA, and Ohio EPA personnel] responsibility to evaluate the risk to receptors from the exposure to residual contamination in a release block prior to transfer. To evaluate this residual risk, the core team has identified the appropriate exposure pathways, parameters and equations for performing a residual risk evaluation for industrial use.[16]" DOE and these regulators agreed that it would be appropriate to evaluate each "potential release site" (PRS) or building separately, use removal action authority to remediate them as needed, and establish a goal for no additional remediation other than institutional controls for the final remedy for each release parcel.[17] This protocol was referred to as the Mound 2000 Approach. As of October 1999, two parcels of land (which include two buildings) had been transferred to the MMCIC under this sales agreement.[18] Two additional land parcels are scheduled for transfer to the MMCIC in FY01.

Based on the planned exit of DOE from the Mound site, the Department proposed relocating the HS/RTG assembly and test operations from the Mound site to a technically capable site with a continuing long-term Departmental presence.[19] The preparation of an environmental impact statement (EIS) to evaluate potential alternate sites was initiated in the fall of 1998. However, on March 22, 1999 the Secretary of Energy announced that the HS/RTG space power system program would remain at MEMP and ordered DOE to terminate the preparation of the EIS related to the proposed relocation of the operation.[20] DOE accepted a proposal for preserving the MEMP RTG capability by minimizing both technical risk and cost.[21] Presently, the DOE has the responsibility to maintain the availability of HS/RTGs for the U.S. Government. DOE has projected requirements to provide such power systems through FY 2009.[22]

ALTERNATIVES CONSIDERED FOR REAL PROPERTY PARCEL TRANSFER

DOE originally developed the goal of privatizing the ownership of the Mound site property in 1989 and signed an agreement to sell the property to the MMCIC in 1998.[23] Once DOE made the decision to privatize ownership of the site, DOE developed policies and procedures to lease excess real property (e.g., buildings, parking lots) to the MMCIC and ultimately, to sell parcels of the Mound site to the MMCIC. DOE considered two primary alternatives regarding the decision to transfer property:

1. *No Action.* Regulations governing the CERCLA program require that the “No Action” alternative be evaluated at each site to establish a baseline for comparison. Under the No Action alternative, DOE would take No Action to prevent exposure to contaminants associated with a release block.[24]

2. *Institutional Controls.* Under this alternative, institutional controls in the form of deed restrictions would be placed on the release blocks prior to their transfer to the MMCIC. The objective of these institutional controls would be to prevent an unacceptable risk to human health and the environment by restricting the use of a release block. DOE and its successors would retain the right and responsibility to monitor, maintain, and enforce these institutional controls.[25]

The alternative of implementing institutional controls prior to transferring the property was selected when Mound transferred the two release blocks, “D” and “H” to the MMCIC. This preferred option is in line with the overall goal of transferring the Mound site to private ownership for economic development.

DECISION-MAKING CRITERIA FOR REAL PROPERTY PARCEL TRANSFER

Each release block proposed for transfer must go through a residual risk evaluation (RRE) in accordance with CERCLA prior to transfer to a non-DOE entity.[26] The purpose of the RRE is to evaluate the cumulative risk impact of residual contamination within the release block to ensure the parcel as a whole does not pose an unacceptable risk to human health and the environment.

DOE must also complete a National Environmental Policy Act (NEPA) review as required under 10 CFR 1021.[27] DOE relies on the CERCLA process for a review of actions taken under CERCLA to meet environmental objectives of NEPA [per the Secretarial Policy for NEPA, Section E, dated June 1994].[28] Then, DOE supplements its CERCLA review with any additional, necessary NEPA evaluations. Prior to transferring the land, US EPA and Ohio EPA must concur that DOE has met its NEPA review requirements.[29]

Thus, guided by the requirements of CERCLA, each release block proposed for transfer is evaluated using the following criteria:[30]

1. *Overall Protection of Human Health and the Environment* – addresses whether or not a closure method provides adequate protection, and describes how risks posed through each pathway are eliminated, reduced, or controlled through engineering or institutional controls.

2. *Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)* – addresses whether or not a closure method will meet all of the ARARs of other Federal or State environmental statutes and/or provide grounds for invoking a waiver.

3. *Long-Term Effectiveness and Permanence* – refers to the magnitude of residual risk and the ability of a closure method to maintain reliable protection of human health and the environment over time once closure goals have been met.

4. *Reduction of Toxicity, Mobility, or Volume through Treatment* – refers to the anticipated performance of the treatment technologies that may be employed in a closure method.

5. *Short-Term Effectiveness* – refers to the speed with which the closure method achieves protection, as well as the method's potential to create adverse impacts on human health and the environment that may result during the closure period.

6. *Implementability* – refers to the technical and administrative feasibility of a closure method, including the availability of materials and services needed to implement the chosen solution.

7. *Cost* – includes the capital, operation and maintenance costs.

8. *State Acceptance* – indicates whether, based on its review of planning and decisions documents, the State concurs with, opposes, or has no comment on the preferred closure alternative.

9. *Community Acceptance* – can be assessed through the recommendations of the MMCIC Advisory Board.

The first two criteria are defined by CERCLA as "threshold criteria," meaning these criteria "must be met for an alternative to be eligible." Criteria three through seven are defined as "balancing criteria," meaning they are used to weigh major trade-offs among alternatives. Criteria eight and nine are known as "modifying criteria," meaning they are to be considered after public comment is received on the proposed plan and of equal importance to balancing criteria.

CONSIDERATION OF LONG-TERM STEWARDSHIP IN DECISION-MAKING FOR REAL PROPERTY PARCEL TRANSFER

Four of the nine criteria implicitly consider aspects of long-term stewardship: *Overall protection of human health and the environment; Compliance with ARARs; Long-term effectiveness and permanence;* and *Cost.*

Overall protection of human health and the environment

The "No Action" alternative does not meet this criterion in that the level of risk to human health posed by the site was found to be acceptable only for "industrial use." Deed restrictions are therefore required as a mechanism to ensure the release block remains for "industrial use" only.[31] In order to maintain protection of human health and the environment for the first two release blocks transferred to the MMCIC institutional controls will be used to:

- Ensure that industrial land use is maintained;
- Prohibit the use of bedrock ground water;
- Provide site access for federal and state agencies for the purpose of taking response actions, including sampling and monitoring; and
- Prohibit removal of soils from within the Mound Property boundary without approval from the Ohio Department of Health.

Similar institutional controls may be imposed on future land parcel transfers. DOE or its successors retain the right and responsibility to monitor, maintain, and enforce these institutional controls.[32] This responsibility includes the duty to conduct annual assessments of compliance with the deed restrictions and the duty to enforce the deed restrictions if any noncompliance is detected.[33]

Institutional controls must be implemented, maintained, funded, and enforced to remain effective. For instance, establishing institutional controls *per se* does not itself assure that future users of the site will adhere to the restrictions at all times and with respect to all uses.[34] For example, the effectiveness of deed restrictions on prohibiting removal of soils from the Mound Property may be compromised if the circumstance of looking up such a restriction is not a typical act for an excavation contractor.[35] Information available for this review does not indicate DOE's specific activities and enforcement plans to effectively protect public health and the environment in cases such as this. For example:

- Will “deed restrictions” be sufficient to achieve cleanup goals or will multiple institutional controls be necessary?
- If multiple institutional controls are proposed, how do they interface or compliment one another?
- If corrective action is needed off-site, are the necessary institutional controls in place?
- Do the proposed enforcement and funding plans seem plausible for the proposed institutional controls?
- Will the institutional controls be adversely affected if there is a change in ownership of the property?

As evidenced in a report on Mound by the DOE’s Office of Environment, Safety and Health, DOE must consider the health and safety concerns that accompany transferring contaminated property. It has already been documented that corrective actions were required on the site due to residual site risks and hazards.[36]

Compliance with ARARs

Section 121(d) of CERCLA requires that remedial actions at CERCLA sites attain legally applicable or relevant and appropriate Federal and State requirements, standards, criteria, and limitations which are collectively referred to as “ARARs.” Compliance with ARARs addresses whether a remedy will meet all the applicable or relevant and appropriate requirements of other Federal and State environmental statutes or provides the basis for invoking a waiver.

The use of institutional controls will allow DOE to meet ARARs for residual contamination only if the institutional controls function as planned and are maintained and enforced adequately. For example, if restrictions on the excavation of soil are not readily known or available to contractors and future tenants, public health may be compromised. Moreover, well drilling restrictions and access agreements must be recorded in such a fashion that any new owners or lessees will be notified of such restrictions and agreements. Compliance with ARARs is dependent upon how effectively institutional controls function. This, in turn, requires the DOE to consider long-term stewardship obligations when choosing which institutional controls will be implemented and how such controls will be recorded, maintained and enforced.

Long-term effectiveness and permanence

Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met. This criterion includes the consideration of residual risk and the adequacy and reliability of controls. The implementation of institutional controls in the form of land use restrictions is necessary to ensure that future use remains compatible with the evaluated residual risk associated with a release block. Annual reviews and reports must be submitted to OEPA, Ohio Department of Health (ODH), and USEPA (pursuant to CERCLA) determining whether or not the remedy is in effect and being complied with to ensure that it is adequately protective of human health and the environment. Moreover, DOE will have the responsibility for assuring that the remedy of institutional controls is effective in perpetuity, as delegated by the

Executive Order 12580 and Title 40 of the *Code of Federal Regulations,* Part 300. DOE reserves the right to petition the USEPA, OEPA, and ODH for a modification to the frequency established for conducting the effectiveness reviews.[37]

Several issues are related to the responsibility of ensuring the long-term effectiveness and permanence of institutional controls.

1. Will DOE, as the responsible entity for assuring the effectiveness of the institutional controls, remain a viable agent to carry out the necessary duties for the amount of time required?

2. Will enforcement be compromised if the property is transferred to new owners?

3. Is the administrative infrastructure sufficient to ensure the maintenance, enforcement and recordkeeping requirements that accompany institutional controls?

Documentation available for this review does not detail how the recording of notifications, restrictions and conditions imposed on parcels will be readily available to site inspectors and other personnel to expedite enforcement.

Cost

The estimated long-term stewardship costs for these two alternatives is $0 for the "No Action" alternative and up to $5,000 a year for the maintenance of the deed restrictions for Alternative 2, "Institutional Controls." The initial costs for these deed restrictions are those associated with the writing and recording of the restrictions with the deed. A detailed breakdown of how DOE arrived at these estimates was not provided in the ROD, or other available documents. Moreover, the documentation available for this review does not identify all of the necessary activities required to effectively manage institutional controls that will be in place in perpetuity.

Costs for long-term stewardship activities for the Mound site are budgeted at $50,000 per year starting on FY 2007, according to the Report to Congress on Long-Term Stewardship. Costs for long-term stewardship activities are estimated out to FY 2070, although long-term stewardship activities are expected to be required in perpetuity. These costs include all long-term stewardship requirements for the entire site, including the area currently identified for use by NE. These costs are associated with the monitoring, maintaining and enforcement of institutional controls required at the site.[38]

CONCLUSIONS

The decisions to (1) privatize the Mound plant and transfer property on a parcel-by-parcel basis and (2) maintain the HS/RTG facility on-site despite the property transfer and privatization result in significant long-term stewardship requirements.

1. Due to residual contamination, DOE or another entity must effectively implement, enforce, fund, and maintain institutional controls throughout the privatization process

and over the long-term management of the site in order to ensure adequate protection of public health; and,

2. Continued operation of the HS/RTG at Mound will require DOE to maintain a small facility handling nuclear materials in close proximity to the public.

The documentation available for this review does not describe explicitly how long-term stewardship considerations and obligations factored into the decision-making process. For example:

1. How were long-term stewardship requirements considered in the decision-making process when DOE decided to transfer the site parcel by parcel?

2. How were long-term stewardship requirements considered when DOE chose specific institutional controls?

3. How were long-term stewardship requirements considered during the decision to maintain the HS/RTG facility on-site?

4. How will DOE or MMCIC train private, on-site workers in case of emergency response actions resulting from an accident either from the HS/RTG or from residual contamination?

5. If DOE does train tenants, how will it enforce readiness, training and response actions of private, non-DOE workers? If DOE does not train these workers, who will?

The information available for this review does not describe policy and implementing guidance pertaining to protection of worker safety and health associated with the leasing of space to private companies and workers at facilities such as MEMP, where operations or decontamination and decommissioning (D&D) are not yet complete. For example, in a site profile of the Mound plant, the Department of Energy's Office of Environment, Safety and Health stated, "to promote commercialization, which was authorized by Congress and strongly supported by DOE Headquarters, the DOE Ohio Field Office authorized leasing of MEMP facilities before clearly identifying hazards and controls, fully assessing the potential impact of accidental releases or radioactivity on lessees, or developing an effective emergency management program involving lessees."[39] The available documentation does not describe the policies and practices implemented to avoid such occurrences in the future, or how such policies and practices can be enforced.

DOE issued a FONSI regarding the consolidation of Heat Source/Radioisotope Thermoelectric Generator (HS/RTG) Assembly and Test Operations in April 2000. However, the document does not describe the degree to which long-term stewardship issues were considered and, furthermore, how DOE will manage long-term stewardship obligations when they arise. Maintaining this facility as a DOE "island" adjacent to the industrial park may represent a safe and effective way to operate the HS/RTG facility. But, DOE long-term stewardship plans and procedures must be in place and adequately explained to all stakeholders and the public.[40]

ENDNOTES

1. *What Gets Measured Gets Done: Our Road Map for Excellence in Environmental Restoration and Employee/Community Transition*. Ohio Field Office Strategic Plan. October 1, 1999.

2. *Miamisburg Environmental Management Project Site Profile.* Office of Oversight, Environment, Safety, and Health. U.S. Department of Energy. December 1999.

3. Ibid.

4. Ibid.

5. *Work Plan for Environmental restoration of the DOE Mound Site, The Mound 2000 Approach.* U.S. Department of Energy. February 1999.

6. Http://www.lastinglegacy.net/legacy3.1/site/oh/mdgenl.htm

7. Notice of Intent. Federal Register. October 2, 1998, Vol. 63, Number 191.

8. Ibid.

9. *DOE-Mound's Land Transfer Process*. Developed by: Department of Energy – Miamisburg Environmental Management Project, in coordination with: the United States EPA, the Ohio EPA, and the Miamisburg-Mound Community Improvement Corporation. December 1999.

10. Ibid.

11. "Remarks by Secretary of Energy Bill Richardson Mound Land Transfer Event" Miamisburg, OH, March 22, 1999.

12. Ibid.

13. Notice of Intent. Federal Register. October 2, 1998, Vol. 63, Number 191.

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16. Ibid.

17. *Record of Decision for Release Block D, Mound Plant, Miamisburg, Ohio.* U.S. DOE, February, 1999.

18. Ibid.

19. Notice of Intent. Federal Register. October 2, 1998, Vol. 63, Number 191.

20. "Remarks by Secretary of Energy Bill Richardson Mound Land Transfer Event" Miamisburg, OH, March 22, 1999.

21. *Miamisburg Environmental Management Project Site Profile*. Office of Oversight, Environment, Safety and Health, U.S. Department of Energy. December 1999.

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24. *Record of Decision for Release Block H, Mound Plant, Miamisburg, Ohio.* U.S. DOE, June 1999.

25. Ibid.

26. *DOE-Mound's Transfer Process.* Developed by: Department of Energy – Miamisburg Environmental Management Project, in coordination with: the United States EPA, the Ohio EPA, and the Miamisburg-Mound Community Improvement Corporation. December 1999.

27. Ibid.

28. Ibid.

29. Ibid.

30. *Record of Decision for Release Block H, Mound Plant, Miamisburg, Ohio.* U.S. DOE, June 1999.

31. Ibid.

32. Ibid.

33. Ibid.

34. *Institutional Controls Case Study: Mound Plant.* Environmental Law Institute Research Report. 1998.

35. Ibid.

36. *Miamisburg Environmental Management Project Site Profile.* Office of Oversight, Environment, Safety and Health, U.S. Department of Energy. December 1999.

37. Ibid.

38. *A Report to Congress on Long-Term Stewardship. Volume II – Site Summaries*. DOE/EM00563. January 2001.

39. Ibid.

40. *Finding of No Significant Impact: Consolidation of Heat Source/Radioisotope Thermoelectric Generator (HS/RTG) Assembly and Test Operations.* April 2000.

APPENDIX D

SAVANNAH RIVER SITE HIGH-LEVEL WASTE TANKS CLOSURE

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SAVANNAH RIVER SITE HIGH-LEVEL WASTE TANKS CLOSURE

INTRODUCTION

The DOE SRS occupies 803 square kilometers (310 square miles) in a rural area of southwest-central South Carolina. SRS produced plutonium and tritium for the nation's defense program from the early 1950s to the late 1980s. To support this mission, five plutonium and tritium production reactors were built, in addition to support facilities (including two chemical separations plants, a heavy water extraction plant, a nuclear fuel and target fabrication facility, and waste management facilities.) Today, SRS continues to process, recycle, and store nuclear materials. The complex also conducts environmental, such as developing nuclear and hazardous waste treatment technologies.

High-level radioactive waste at SRS is stored in 51 high-level waste tanks located in the F- and H- Tank Areas near the geographic center of SRS. In total, these tanks contain about 132 million liters (35 million gallons) of high-level waste (HLW). The waste was generated by the chemical processing of spent fuel and irradiated targets. DOE is required to close all tanks that are not compliant with the operating criteria set out in the Federal Facilities Agreement (FFA) negotiated on August 16, 1993, between DOE, the Environmental Protection Agency (EPA), and the South Carolina Department of Health and Environmental Control (SCDHEC). The FFA states, "The DOE's waste tank system(s) removal plan(s) shall provide for the removal or decontamination of all residues ... If the DOE demonstrates that it cannot practicably remove or decontaminate soils or structures and equipment, then the DOE shall conduct all necessary response actions under Section XI through XVI of this Agreement for those waste tank system(s)."[1]

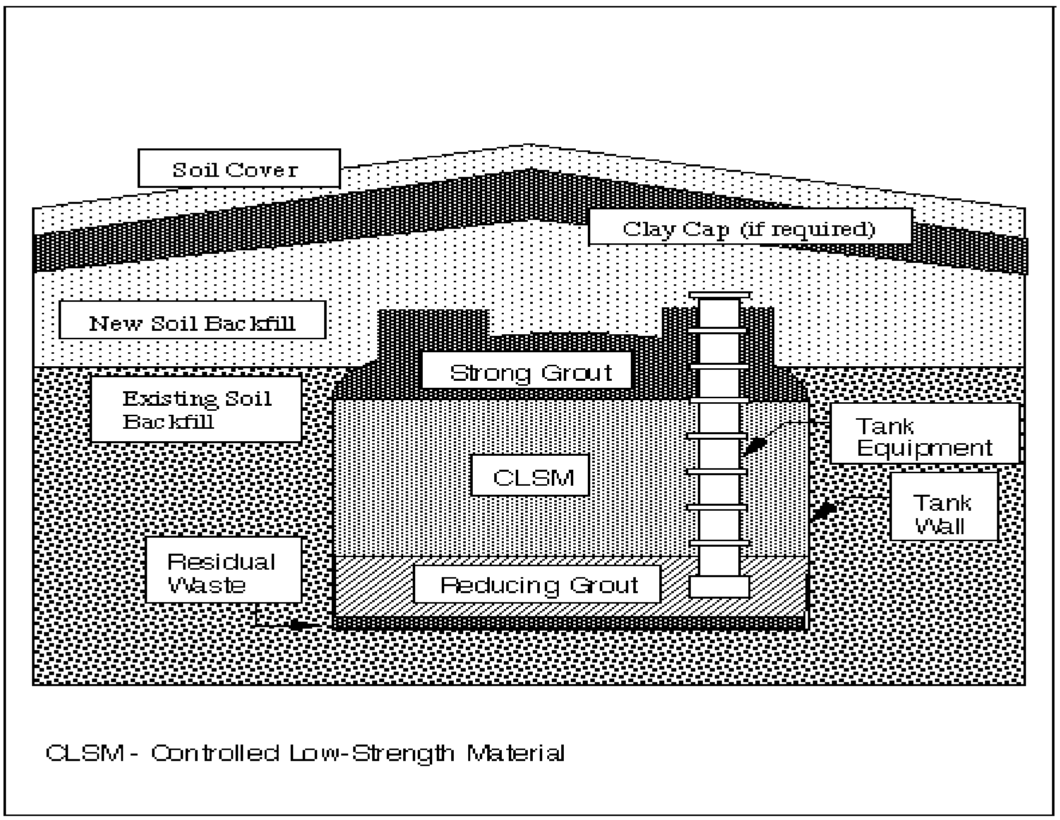
In July 1996, DOE prepared the *Environmental Assessment for Closure of the High-Level Waste Tanks in F- and H- Areas at the Savannah River Site*.[2] Following the completion of the Environmental Assessment and a subsequent *Finding of No Significant Impact*,[3] two of the HLW tanks in the F-Tank Area were closed by removing bulk (liquid) HLW from the tanks and then filling the tanks with "pumpable backfill material" (grout and concrete). Twenty-two HLW tanks remain open in the F-Tank Area, and twenty-nine more are located in the H-Tank Area. DOE is committed to the closure of one additional tank by 2003 under the terms of the FFA. Twenty-four more tanks must be closed by 2022 and the remainder by 2028. On December 29, 1998, DOE released a Notice of Intent to prepare an Environmental Impact Statement (EIS) for closure of the remaining HLW tanks.[4] DOE will select a methodology for the closure of the remaining tanks in the Record of Decision for the EIS.

This case study analyzes the selection of a closure method for the two F-Area tanks that have already been closed. This study does not evaluate the decision-making process for the closure of the remaining tanks in F- and H-Areas. The study presents a description of the decision to close the two F-Area tanks, the alternatives considered, and the decision-making criteria utilized. It evaluates the extent to which long-term stewardship needs and costs were considered in the decision-making process. The study also identifies the implications of the decision with respect to long-term stewardship needs and costs for the two closed tanks.

DESCRIPTION OF PROJECT

DOE's selected method of tank closure for the 51 tanks in the F- and H- Tank Areas is illustrated in Figure 1. Bulk waste was removed, leaving residual high-level radioactive waste at the bottom of the tanks. This "heel" of residual waste was covered with three layers of pumpable backfill material. The first layer was a reducing grout, which reduced the mobility of radionuclides (including cesium-137, strontium-90, technetium-99, neptunium-237, americium 241, uranium-238, and plutonium-238 through 241). The middle layer was Controlled Low-Strength Material (CLSM), a self-leveling concrete composed of sand and cement formers. The top layer was a strong grout with compressive strengths in the normal concrete range.

Figure 1: Closure Method For Tanks F-17 and F-20



If required, an engineered cap consisting of clay, backfill (soil), and vegetation as the final layer to prevent erosion would be applied over the tanks.[5] No information was available for this review that indicates the conditions under which such a cap would be deemed necessary.

The liquid HLW extracted from the two tanks will be treated to separate the high-activity fraction from the low-activity fraction. The high-activity fraction was transferred to the on-site Defense Waste Processing Facility and mixed into borosilicate glass to immobilize the radioactive constituents. Stainless steel canisters containing the borosilicate glass are being stored in Glass Waste Storage Buildings at SRS, pending a decision on disposal in a geologic repository. The low-activity fraction was transferred to the on-site Saltstone Facility and mixed with grout to make saltstone. The resulting material was disposed on-site in the concrete vaults of the Saltstone Landfill Area.

ALTERNATIVES CONSIDERED

Five alternatives were considered in the selection of a method for tank closure. Each was evaluated based upon CERCLA remedy selection criteria and specific criteria designated in the Tank Closure Plan.[6]

1. *Alternative 1A: "Bulk waste removal, clean, fill tanks with pumpable backfill material"* Following bulk waste removal and cleaning, a performance evaluation would be developed based upon an inventory of contaminants present. Assuming the performance objectives were met, closure would continue to the stabilization phase, in which the tank would be filled with a pumpable, self-leveling backfill material. Although the details of each individual closure would vary, any tank system closure would share the following characteristics: (1) the fill material would be pumpable, self-leveling, designed to prevent future subsidence of the tank, and designed to fill voids to the extent possible; (2) the fill material would reduce the migration of radionuclides; (3) the fill configuration would discourage inadvertent intrusion; and (4) the "final closure configuration would meet performance objectives established by SCDHEC and EPA."[7] Further information on the details of these performance objectives and their implementation was not available for this study.

2. *Alternative 1B: "Bulk waste removal, clean, fill tanks with sand"* Bulk waste would be removed and a performance evaluation developed as above. Stabilization would be completed using sand instead of pumpable backfill material.

3. *Alternative 1C: "Bulk waste removal, clean, fill tanks with saltstone"* Bulk waste would be removed and a performance evaluation developed as above. Stabilization would be completed using saltstone instead of pumpable backfill material.

4. *Alternative 2: "No Action, bulk waste removal, no fill material, abandonment"* (No Action alternative) Bulk waste would be removed, but the tanks would not be filled with backfill material.

5. *Alternative 3: "Clean to extent allowing removal of the tanks"* Following bulk waste removal, no performance evaluation would be necessary. The tanks would be cleaned to the extent required for safe removal. The tank steel components would be cut up, removed, placed in burial boxes, and transported to the on-site burial grounds for disposal.

Alternative 1a was selected as the method of tank closure and implemented for Tanks F-17 and F-20.

DECISION-MAKING CRITERIA

Nine criteria were used to evaluate the alternatives. These criteria are consistent with the requirements set forth under CERCLA for evaluating and selecting remedies. Specific performance objectives were developed based upon these criteria. An evaluation (including fate and transport modeling) was conducted in relation to these criteria in order to determine the necessary cleaning and stabilization methods for a given tank system. This evaluation was incorporated into the final Closure Module for each tank.[8, 9] Detailed information on DOE's use of the criteria in the assessment of alternatives was not available for this case study. The CERCLA criteria relevant to this case study are listed below.

1. *Overall Protection of Human Health and the Environment* – addresses whether or not a closure method provides adequate protection and describes how risks posed through each pathway are eliminated, reduced, or controlled through engineered or institutional controls.

2. *Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)* – addresses whether or not a closure method will meet all of the ARARs of other Federal or State environmental statutes and/or provide grounds for invoking a waiver.

3. *Long-Term Effectiveness and Permanence* – refers to the magnitude of residual risk and the ability of a closure method to maintain reliable protection of human health and the environment at the Savannah River Site over time once closure goals have been met.

4. *Cost* – includes the capital and operation and maintenance costs. Net present value analysis was used to compare the cost of each alternative.

The first two criteria are defined by CERCLA as threshold criteria, meaning that they "must be satisfied in order for an alternative to be eligible for selection as the preferred remedial alternative." Criteria three and four are defined as primary balancing criteria, meaning that these criteria are used to weigh the alternatives.

CONSIDERATION OF LONG-TERM STEWARDSHIP IN THE DECISION-MAKING PROCESS

Compliance with ARARs

The relevant regulatory and permitting provision considerations are identified in the Environmental Assessment. The first such consideration is the National Environmental Policy Act of 1969 (42 USC 4321 et seq), which requires the preparation of a detailed statement of potential environmental impacts of major federal actions such as closure of the SRS HLW tanks. The second consideration is the Federal Facilities Agreement, which provides standards for secondary containment, requirements to responding to leaks, and provisions for the removal from service of leaking or unsuitable HLW storage tanks. The third consideration is the SCDHEC Wastewater Permit, which regulates the removal of waste from the HLW tanks. Additional applicable regulatory requirements are identified in the Tank Closure Plan.[10]

Long-Term Effectiveness and Permanence

This criterion was used to determine the potential impacts that the closure alternatives would have on human health and the environment. DOE analyzed the environmental and health risks associated with each alternative and assessed how successful each alternative would be in protecting both human health and the environment. The following descriptions summarize our understanding of the environmental and health risks associated with each alternative, derived from the documentation available. However, we do not have sufficient information to fully understand the differences among the alternatives in terms of long-term effectiveness and permanence. The precise groundwater and surface water concentration figures derived from DOE models were not available for this case study, so it is not possible to compare the modeled contamination levels (e.g., concentration, arrival time).

Alternative 1a over the short term, maintains the structural integrity of the tank through the use of backfill (in comparison to Alternative 2), although the tanks are expected to fail "several hundred years after tank closure when the tank, grout, and base mat are anticipated to fail due to deterioration."[11] DOE concluded that Alternative 1a would be more effective at preventing the flow and spread of radionuclides over time than Alternative 1b or Alternative 1c.

Alternative 1b would pose a greater risk to human health and the environment than would Alternative 1a. Sand is more porous than pumpable backfill material, and it permits water to flow unimpeded, readily transporting contaminants into the soil and groundwater. In addition, sand is relatively inert and would not impede the migration of radionuclides from the residual waste in the closed tanks into the soil and groundwater.

Alternative 1c would pose a greater risk to human health and the environment than would either Alternative 1b or Alternative 1a. The saltstone grout mixture produced in the Saltstone Facility would be contaminated with radionuclides, which would increase the risk of this alternative in comparison to Alternative 1a and Alternative 1b.

Alternative 2 would pose the greatest risk to human health and the environment. This "no-action" alternative was analyzed strictly for baseline purposes. Under this alternative, the Environmental Assessment anticipates the degradation of the structural integrity of the tanks "after some period of time."[12] Models predict that the reinforcing bar in the roof of the tank would rust and the roof would fail. Rainwater would readily enter the tanks, flushing contaminants into the groundwater. Movement of contaminants from the residual waste in the tanks into the groundwater would be most rapid under this alternative, and expected contamination levels in both groundwater and surface streams are highest.

Alternative 3 would pose the least risk to human health and the environment. It would result in no migration of residual contaminants or consequent impacts at the location of Tanks F-17 and F-20, since the tanks and all residual waste would be completely removed from the ground. Long-term stewardship activities would still be required at the SRS Burial Ground, where residual waste from the tank removal would be disposed.[1]

Cost

Cost estimates for the five alternatives appear to be based primarily upon capital (i.e., construction) costs. The DOE figures in Table 1 represent the cost estimates for the closure of a single tank under each alternative.

[1] Based on the experience of other waste removal actions, long-term stewardship activities (including surveillance and monitoring of groundwater and soil) would be required for the short term to determine whether the waste removal action was effective. Theoretically, EPA and SCDHEC would ultimately determine (based on surveillance and monitoring data) that the waste removal action was effective and would allow DOE to discontinue surveillance and monitoring of the site. However, the groundwater under tanks F-17 and F-20 is heavily contaminated resulting from previous DOE operations. Therefore, it is unlikely that the area surrounding tanks F-17 and F-20 would ever be released for unrestricted use, even if both the tank waste and the tanks themselves were removed. However, leaving the tanks and their associated residual contamination in the ground will likely add to the existing soil and groundwater contamination in the vicinity of the tank farm, as SRS has acknowledged that the residual contamination will eventually migrate into the soil and groundwater.

Table 1: Cost Estimates for Single Tank Closure

Alternative	Cost (FY1996 Dollars)
1a	$2.5 million
1b	$2.5 million
1c	$5 million
2	$56,000
3	$50 million

Although Alternative 2 would be the least expensive, it was deemed unacceptable by DOE due to associated high long-term risk to human health and the environment. Precise figures were not available to the reviewers for comparative risk evaluations of the five alternatives evaluated in the EA.

In comparison, although Alternative 3 is predicted to pose the least risk to human health and the environment, its high cost was deemed by DOE to be prohibitive. Additional costs may also be incurred through the need to construct new disposal facilities at SRS to accommodate the burial of the tanks. However, information on the costs associated with the alternatives were not evaluated in the EA or other documents that were available for this review.

IMPLICATIONS OF THE DECISION WITH REGARD TO LONG-TERM STEWARDSHIP

Based on our analysis, long-term stewardship activities will be required for the F- and H-Tank Areas regardless of the alternative selected. Alternatives 1a, 1b, 1c and 2 will require surveillance and monitoring of the residual HLW in the closed tanks, and Alternative 3 will require surveillance and monitoring at the burial grounds. However, the information available for this review did not provide details of these requirements associated with each alternative. Therefore, it is not possible for us to assess how long-term stewardship was considered in the decision-making process.

When DOE performed fate and transport modeling (to predict the protection of human health and the environment under each alternative), it modeled two scenarios that were not presented in the list of five alternatives and did not model three of the presented alternatives (see Table 2 below). The additional modeled scenarios involved the use of an engineered cap over the filled tanks. Such an engineered cap might provide increased risk protection or reversibility, although it might also increase long-term stewardship costs and responsibilities for maintenance of the cap. The inclusion of an engineered cap in one or more alternatives might have affected the long-term costs, benefits, and protectiveness of some alternatives.

Table 2: Comparison of Alternatives analyzed in EA and Performance Assessment

Alternative	Analyzed in EA	Analyzed in performance assessment (modeling)
No Action (2)	✔	
Clean to allow removal (3)	✔	
Bulk waste removal, pumpable backfill (1a)	✔	✔
Bulk waste removal, pumpable backfill, engineered cap		✔
Bulk waste removal, sand (1b)	✔	✔
Bulk waste removal, sand, engineered cap		✔
Bulk waste removal, saltstone (1c)	✔	

Additional discussion of long-term stewardship obligations for the five alternatives:

DOE fate and transport modeling assumed institutional controls for the F- and H- Tank Areas over a 100 year period and industrial land use (with deed restrictions on the use of groundwater) over a subsequent 10,000 year period of analysis. The distinction between the two assumptions is not clear, since deed restrictions are a form of institutional controls. Based on these assumptions, the Environmental Assessment predicts that "there will be minimal active operational and maintenance activities in the area."[13] However, neither the Environmental Assessment nor the Finding of No Significant Impact identifies specific institutional controls or maintenance requirements that will be required to secure the area and restrict groundwater use over a 10,000 year period to protect human health and the environment. Therefore, based on the information that was available for this case study, it is unclear how DOE intends to enforce and maintain these institutional controls for 10,000 years.

CONCLUSIONS

After analyzing the closure decision, the decision-making criteria, and the decision-making methodology, we are left with a number of broad questions concerning the impact of long-term stewardship considerations in this decision-making process. Six broad questions are followed by analysis of the three most relevant remedial alternative evaluation and remedy selection criteria.

1. Available documentation does not address how DOE specifically identified the needs and costs of long-term stewardship for each of the alternatives considered in the Environmental Assessment. It is also unclear how DOE considered long-term stewardship needs and costs as criteria in its decision-making process.

2. Available documentation does not address how the consideration of long-term stewardship affected the range of alternatives identified by DOE. Specifically, scenarios involving an engineered cap were modeled but not analyzed as alternatives. The inclusion of an engineered cap in one or more alternatives might have affected the long-term costs, benefits, and protectiveness of some alternatives.

3. Available documentation does not address how the alternatives vary substantively with respect to their overall protectiveness. Although the Environmental Assessment presents qualitative evaluations of higher risk and surface water/concentration values for certain alternatives, information available for this review was not sufficient to make quantitative comparisons with DOE or EPA standards to determine the relative protectiveness of the remedies. For example, information was not available on the rate of release or the composite analysis of the area surrounding the tanks.

4. Available documentation does not address how the alternatives meet the FFA requirement to maintain the integrity of the tanks. Although the time frame for degradation under each alternative varies, each of these four remedial alternatives are projected to result in an eventual loss of integrity. Although surveillance and maintenance activities are assumed to maintain the integrity of the closed tanks over time, DOE does not specifically detail such long-term stewardship activities in the available documentation.

5. Available documentation does not address whether the distinction between “interim” and “permanent” remedies would have led to a different preferred alternative. DOE has indicated that the materials selected for backfill of the tank are low strength materials that may be excavated in the future. Although individual “interim” tank closures are acceptable prior to the closure of the final tank in the system, the Environmental Assessment does not evaluate the ultimate disposition of the excavated material, including treatment, ultimate disposal, and long-term stewardship of the disposed material. Furthermore, if DOE were to be required to excavate the material in the future, Alternative 1b might be preferable to Alternative 1a. The capital cost of the two alternatives is the same, sand is easier to excavate than concrete, contaminated sand is most likely easier to treat or dispose after excavation, and the application of future technological advances will be more feasible for a tank filled with sand than one filled with concrete.

6. Available documentation does not address how DOE intends to enforce institutional controls and land use restrictions in the performance assessments for the alternatives are enforceable. The Environmental Assessment assumed that institutional controls (deed restrictions to restrict groundwater use) for the site will remain effective for a 10,000 year period after closure of the tanks and that land use for the site will remain strictly industrial over the same time period. Available documentation did not indicate the types of institutional controls that will be required at the site to restrict land use to industrial use, nor how such land use restrictions will be effective over a 10,000 year period and how the deed restrictions for groundwater use will be monitored over this time frame.

Overall Protection of Human Health and the Environment

Overall protection of human health and the environment serves as the broadest decision criterion for the selection of Alternative 1a. It combines the two more specific criteria of cost and long term effectiveness and permanence. In the Finding of No Significant Impact (FONSI), the explanation for the selection of Alternative 1a focuses on concerns relating to both cost and long term effectiveness and permanence. According to the FONSI, Alternatives 1b, 1c, 2, and 3 are not selected for the following principal reasons:

> *Alternative 1b*: "Sand would leave voids in the tank and equipment, would not bind with any residual waste, and would not retard migration of the contaminants."
>
> *Alternative 1c:* "Saltstone solidifies quickly which is not desirable for this application, would not be practical to ship by truck from the existing facility, would increase worker exposure because it contains radioactive constituents, and would require regulatory permits."
>
> *Alternative 2:* "Since there is no binding material to retard the discharge of the contaminants, the no-action alternative is not a reasonable alternative but was analyzed for baseline purposes."
>
> *Alternative 3:* "Removal of the tanks would be cost prohibitive, cause large radiation exposures to workers, would require construction of additional burial facilities [at the SRS burial ground], and for these reasons was not considered a reasonable alternative."[14]

The Environmental Assessment concludes that maximum contaminant doses and concentrations will not vary dramatically among the closure alternatives (usually by less than an order of magnitude). However, it is not possible to evaluate the significance of this variation without reviewing the results of modeling for each alternative, which were not available for this case study. Furthermore, although the primary variation among alternatives is projected to be the *arrival time* of the maximum dose/concentration at the seepline several thousand years after closure, information on the *magnitude and duration* of exposure for each alternative were not available for this review.

Cost

Our analysis of the available information indicates that capital cost serves as a primary criterion for the selection of Alternative 1a. This measure, however, may not accurately reflect the true life-cycle cost of each of the alternatives, which would include costs for the long-term stewardship activities required under each alternative. It is not clear how these costs were factored into the analysis.

In the 2000 Report to Congress on Long-Term Stewardship, SRS has estimated the long-term stewardship costs for the 24 tanks in the F-Tank Area.[15]

F-Tank Area Portion ***Long-Term Stewardship Costs (adjusted to 1996 dollars)***[2]							
FY2000 - FY 2010	FY 2011 - FY 2020	FY 2021 - FY 2030	FY 2031 - FY 2040	FY 2041 - FY 2050	FY 2051 - FY 2060	FY 2061 - FY 2070	Estimated Total
$0	$0	$9,557,880	$13,654,640	$13,654,640	$13,654,640	$13,654,640	$64,176,440

Although these figures do not represent long-term stewardship costs for Tanks F-17 and F-20 alone, they do demonstrate the significant scope of long-term stewardship activities that will be required. According to these numbers, the unit cost of maintaining a single tank in the F-Tank Area through 2070 is more than $2.67 million. The Report to Congress states that "once the tank areas are closed, institutional controls and long-term surveillance and maintenance will be required in perpetuity."[16]

Long-Term Effectiveness and Permanence

The 1993 Federal Facilities Agreement for SRS established the requirement that the structural integrity of the tank systems be maintained. This requirement served as the basis for DOE's overall decision to stabilize the tanks. The Environmental Assessment reported: "if the tanks are not stabilized, they would fail in the future, causing tank pollutants to enter the environment."[17] In fact, the no-action alternative (Alternative 2) was discarded based upon the integrity requirement: the reinforcing bar would rust, the roof of the tank would fail, and the structural integrity of the tank would degrade. Rainwater would then pour into the tank, flushing the contaminants into the groundwater.

However, the Environmental Assessment acknowledged that the integrity of the tanks will inevitably degrade, even under the selected alternative: "the major impacts anticipated during post-tank closure would be the release of contamination from the closed tanks due to deterioration of the tanks in future years."[18] The near surface groundwater is expected to become contaminated such that it will not meet SCDHEC standards after several hundred years, when the "tank, grout, and basement are anticipated to fail due to deterioration."[19] This contamination is expected to migrate – over a period of several thousand years – into the groundwater and seepline, although the contaminant levels are projected by DOE to remain within the acceptable stream standard limits. DOE also expects the contamination of the surface water to eventually affect sediment and shoreline, although levels are projected again to remain below regulatory concern. Aquatic organisms, plants, and terrestrial organisms will become exposed to the contaminants.

Available documentation indicates that the structural integrity of the tanks will ultimately be compromised under all alternatives considered except Alternative 3, which involves removing

[2] Calculations made using Consumer Price Index data from the Bureau of Labor Statistics. Assumed 8 percent inflation from 1996 to 2000. http://stats.bls.gov/cpihome.htm. 11/14/1000.

the waste and the tanks to on-site waste treatment, storage, and disposal facilities. Although the length of time before degradation occurs may vary among alternatives, those estimates were not available for this review.

The available documentation did not include the results of analyses that may have been conducted to demonstrate "long-term effectiveness and permanence" of the alternatives. The Environmental Assessment seems to acknowledge the temporary nature of the selected alternative, because a controlled low-strength material (CLSM) was chosen as the middle layer of grout. A significant factor in the selection of CLSM is its potential for excavation "with conventional excavation equipment."[20] Although this option is not planned, DOE notes the possibility for future removal of tank contaminants or the tank itself. The available documentation did not provide information on the specific surveillance and maintenance actions or costs that may be required in the future to appropriately manage the waste over its lifetime and maintain the integrity of the remedy.

ENDNOTES

1. Federal Facilities Agreement for the Savannah River Site. Administrative Document Number 89-05-55. Effective Date: August 16, 1993. WSRC-OS-94-42. http://www.srs.gov/general/srenviro/erd/ffa/ffaa.pdf

2. Department of Energy. Environmental Assessment for Closure of the High-Level Waste Tanks in F- and H- Areas at the Savannah River Site. EA-1164, July 1996. http://www.srs.gov/general/sci-tech/nepa/EA1164/EA1164.HTML

3. Department of Energy. Finding of No Significant Impact for the Closure of the High-Level Waste Tanks in F- and H- Areas at the Savannah River Site. EA-1164, 1996. http://www.srs.gov/general/sci-tech/nepa/EA1164/FONSI1164.HTML

4. Department of Energy. Notice of Intent to Prepare an Environmental Impact Statement for Closure of High-Level Waste Tanks at the Savannah River Site, Aiken, South Carolina. Federal Register Vol. 63 No. 249. Tuesday, December 29, 1998. 71628. http://www.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=1998_register&docid=fr29de98-44

5. EA p2 Section 1.0.

6. Department of Energy. Industrial Wastewater Closure Plan for F and H-Area High-Level Waste Tanks, Preliminary Draft, May 15, 1996, Savannah River Operations Office, Savannah River Site, Aiken, South Carolina. 1996.

7. EA p6 Section 2.1.1

8. Westinghouse Savannah River Company. 1997. Industrial Wastewater Closure Module for the High-Level Waste Tank 17 System. Construction Permit: 17,424-IW, Revision 1, Westinghouse Savannah River Company, Aiken, South Carolina.

9. Westinghouse Savannah River Company. 1997. Industrial Wastewater Closure Module for the High-Level Waste Tank 20 System. Construction Permit: 17,424-IW, Westinghouse Savannah River Company, Aiken, South Carolina.

10. Department of Energy. Industrial Wastewater Closure Plan for F and H-Area High-Level Waste Tanks, Preliminary Draft, May 15, 1996, Savannah River Operations Office, Savannah River Site, Aiken, South Carolina.

11. EA p15 Section 4.6

12. EA p7 Section 2.2.1

13. EA p13 Section 4.2.

14. FONSI

15. Department of Energy. Report to Congress on Long-Term Stewardship. July 2000 Concurrence Draft p13.

16. Ibid p13.

17. EA p 4 Section 1.2.

18. EA p13 Section 4.2.

19. EA p15 Section 4.6.

20. EA p 23 Appendix B.

APPENDIX E

WELDON SPRING SITE REMEDIAL ACTION PROJECT

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WELDON SPRING SITE REMEDIAL ACTION PROJECT

INTRODUCTION

The Weldon Spring Site Remedial Action Project (WSSRAP) is listed on the National Priorities List (NPL) by the United States Environmental Protection Agency (EPA). The 229-acre site is located approximately 30 miles west of St. Louis Missouri.[1] WSSRAP has been separated into four operable units to facilitate remediation. The Weldon Spring Chemical Plant Operable Unit refers to a complex of 44 buildings where uranium ore was once processed, four raffinate pits, two ponds, and two former dump areas. This operable unit included approximately 675,000 cubic meters of contaminated soil and building material, as well as over 200 million gallons of contaminated water.[2,3] The Bulk Quarry Waste and Quarry Residuals Operable Units both refer to contaminated material in and around the site's quarry. The quarry is a 9-acre site that was used in the 1950's and 1960's for the disposal of waste generated during uranium ore processing. The Bulk Quarry Waste Operable Unit refers to the bulk of the loose material that was deposited in the quarry. The Quarry Residuals Operable Unit refers to contaminated, unconsolidated deposits that remain on the walls or within the fissures of the quarry. The Groundwater Operable Unit is still being documented, but it refers to the groundwater underlying the former Main Chemical Plant site.

All waste generated at the Weldon Spring Site is low-level waste in the form of radiologically (e.g., uranium, thorium) and chemically (e.g., PCBs, arsenic) contaminated soil, building debris, contaminated water, and raffinate sludge left behind after the operation of the ordinance works and the uranium ore processing plant. As decided in the Record of Decision (ROD) for the Chemical Plant Operable Unit, DOE is building an on-site disposal facility that will hold over 1.1 million cubic meters[4] of waste from the Weldon Spring Site.

This case study addresses the DOE decision to construct an on-site disposal facility (OSDF), the way in which long-term stewardship issues were considered during the decision-making process, and the implications that this decision has on long-term stewardship obligations. This study includes a description of the decision, the alternatives considered, the decision-making criteria, and the extent to which long-term stewardship needs and costs were considered during the decision-making process.

DESCRIPTION OF PROJECT

In September, 1993 DOE issued *The Record of Decision for Remedial Action at the Chemical Plant Area of the Weldon Spring Site*. The Record of Decision presented the remedial action alternatives that were considered for the site, and the remedial action that was decided upon. The selected remedy for the Chemical Plant Area was removal, treatment, and disposal of the waste in an on-site disposal facility. The OSDF is still under construction, but as of October, 2000, the facility held 98 percent of its expected total waste capacity.

Chemical stabilization/solidification is being used to treat contaminated sludge, some quarry soil and sediment, and soil from other parts of the site. This treatment results in a volume increase of about 30 percent. Structural material and other debris are undergoing volume reduction, which is expected to be between 10 percent and 50 percent. Two treatment facilities (one for sludge processing, and one for volume reduction) have been built on-site. Overall, roughly one quarter of all the Chemical Plant waste will be treated.[5]

On-site disposal included the construction and operation of an on-site disposal facility (OSDF) and its associated leachate collection and treatment system. The OSDF is located in the northeastern portion of the Chemical Plant Site. The waste disposal area of the facility is expected to have a footprint of approximately 40 acres, and the total facility footprint (including buffer zone) is expected to be 70 acres.

Construction of the on-site disposal facility began in March, 1997. The facility began accepting waste in the spring of 1998, and final closure of the facility is expected in 2001. Upon completion, the facility will average 73 feet in height, and will contain an estimated 1.1 million cubic meters of waste. The facility will consist of an 8-foot multilayer cover which includes an infiltration/radon attenuation barrier, a bio-intrusion layer, and an erosion protection layer. The OSDF also includes a leachate collection system that will also act as a detection system to monitor the cell integrity.

ALTERNATIVES CONSIDERED

The alternative was chosen through a process very similar to the one outlined in CERCLA. A Feasibility Study was conducted to identify and analyze the major remedial action alternatives. The final decision in the ROD was concurred upon by the DOE, U.S. Environmental Protection Agency, and the Missouri Department of Natural Resources.[6]

The evaluated remedies were chosen from among 25 alternatives identified and screened in the Feasibility Study for Remedial Action at the Chemical Plant Area at WSSRAP released in November 1992.[7] In addition to the No Action alternative that is required by CERCLA, the 24 other remedial alternatives were devised by evaluating each of the six possible remedial actions with four different disposal sites. These possible remedial actions and disposal sites are listed in Table 1.

Table 1: Preliminary Alternatives for the Chemical Plant Area of Weldon Spring Site	
Technologies and Remedial Actions	Disposal Site
1. No Action	A. On-Site
2. In-Situ Containment and Limited Disposal	B. Envirocare Facility near Clive, UT
3. In-Situ Chemical Stabilization/Solidification and Limited Disposal	C. DOE Hanford site near Richland, WA
4. In-Situ Vitrification and Limited Disposal	D. Hypothetical nearby site in Missouri
5. Removal, Minimal Treatment, and Disposal	
6. Removal, Chemical Stabilization/Solidification, and Disposal	
7. Removal, Vitrification, and Disposal	

Only five of the twenty-five alternatives underwent detailed analysis in the Feasibility Study. These alternatives were evaluated and compared in the Record of Decision:

- Alternative 1: *No Action*. This alternative provided a baseline against which other alternatives were compared. No remedial action would be taken under this alternative.

- Alternative 6a: *Removal, chemical stabilization/solidification, and disposal on-site*. This alternative involves the removal of contaminated material, and treatment by chemical stabilization (solidification). Two new facilities would be constructed on-site to perform stabilization and reduction of the waste. An engineered on-site disposal facility would be constructed, and the treated material would be disposed of in the engineered on-site disposal facility.[8]

- Alternative 7a: *Removal, vitrification, and disposal on-site*. This alternative includes removal of the contaminated material from their source areas, treatment of the waste by vitrification, and disposal in an on-site engineered disposal facility. As in Alternative 6a, an engineered on-site disposal facility would be constructed as part of this remedy.[9]

- Alternative 7b: *Removal, vitrification, and disposal at the Envirocare facility*. This alternative is the same as Alternative 7a, except the remedy involves transportation of the treated waste and disposal at the privately owned and operated Envirocare facility near Clive, Utah.[10]

- Alternative 7c: *Removal, vitrification, and disposal at the Hanford Reservation*. This remedial alternative is the same as Alternatives 7a and 7b, except it involves transportation of the treated waste and disposal in an engineered cell at the federally-owned and operated Hanford site near Richland, Washington.[11]

Alternative 6a was chosen as the selected remedy in the ROD.

DECISION-MAKING CRITERIA

Screening Criteria

Most of the challenges to remediation of the Weldon Spring site were technological. The site held a variety of waste types, some of which were highly mobile and very hazardous. As a result, the alternatives that were considered, and the methodologies for screening the alternatives were motivated primarily by technical criteria.

The 25 preliminary alternatives that were considered were the result of various technical studies and analyses. Two engineering studies - *Engineering Analysis of Remedial Action Alternatives, Phases I and II* - were prepared to inform the Weldon Spring decision-makers about the feasibility of various remedial technologies.[12] These studies were used in Chapter 3 of the Feasibility Study for the Chemical Plant Area to screen the various technology options, resulting in 25 possible preliminary alternatives.

These 25 alternatives were then further screened based on non-technical criteria. These criteria were used to eliminate alternatives that either provided no added value, were cost-prohibitive, were difficult to implement, or did not meet a basic standard of effectiveness. These screening criteria included:[13]

1. *Effectiveness* – evaluates how effective the remedy is in protecting human health and the environment in the both the short- and long-term; also assesses expected maintenance, certainty of engineered controls, and waste mobility and volume.

2. *Implementability* – resource availability, administrative feasibility, and level of difficulty of carrying out the remedial alternative.

3. *Cost* – comparative evaluation of estimated costs, as well as cost-effectiveness (i.e, whether the benefit of a remedy justifies an increased cost).

Evaluation Criteria

Once the alternatives were screened, nine criteria were used to evaluate the five remaining alternatives. These criteria are consistent with the requirements set forth under CERCLA for evaluating and selecting remedies:[14]

1. *Overall Protection of Human Health and the Environment* – addresses whether or not a remedy provides adequate protection, and describes how risks posed through each pathway are eliminated, reduced, or controlled through engineering or institutional controls.

2. *Compliance with Applicable or Relevant and Appropriate Requirements* (ARARs) – addresses whether or not a remedy will meet all of the ARARs of other Federal or State environmental statutes and/or provide grounds for invoking a waiver.

3. *Long-Term Effectiveness and Permanence* – refers to the magnitude of residual risk and the ability of a remedy to maintain reliable protection of human health and the environment at the Fernald site over time once cleanup goals have been met.

4. *Reduction of Toxicity, Mobility, or Volume through Treatment* – the anticipated performance of the treatment technologies that may be employed in a remedy.

5. *Short-Term Effectiveness* – refers to the speed with which the remedy achieves protection, as well as the remedy's potential to create adverse impacts on human health and the environment that may result during the construction and implementation period.

6. *Implementability* – the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement the chosen solution.

7. *Cost* - includes the capital and operation and maintenance costs. Net present value analysis was used to compare the cost of each alternative.

8. *State Acceptance* – indicates whether, based on its review of planning and decision documents, the State concurs with, opposes, or has no comment on the preferred remedial alternative.

9. *Community Acceptance* – addresses the formal comments made by the community on the alternatives under consideration.

The first two evaluation criteria are defined by CERCLA as "threshold criteria", meaning that they "must be satisfied in order for an alternative to be eligible for selection as the preferred remedial alternative." Criteria three through seven are defined as "primary balancing criteria", meaning that these criteria are used to weigh the alternatives. Criteria eight and nine are defined as "modifying criteria," which means they are taken into account after public comment is received on the Proposed Plan.

CONSIDERATION OF LONG-TERM STEWARDSHIP IN DECISION-MAKING

Screening of Remedial Alternatives

One of the apparent goals of the screening process was to reduce reliance on long-term stewardship activities. If the waste were not treated or disposed of adequately, there would be increased risk to human health and the environment, and long-term stewardship activities would be relied upon heavily to monitor the waste and keep receptors away from the contamination. Under this scenario, long-term stewardship activities would have been the primary method of protection. The alternatives that remained after screening combined treatment, removal and disposal of the waste, and long-term stewardship activities to maintain protection of human health and the environment.

The screening process took long-term stewardship into consideration through the following premises of what was required to meet the standard of “effectiveness”:

- Minimize dependence on unreliable controls.
- Minimize the quantity of waste that will require long-term stewardship and the risk associated with the waste.

As a result of applying these two criteria, all of the remedial alternatives that were evaluated in the ROD included both treatment of contaminated material (sludge, soil, etc.), and containment of the material in an engineered disposal cell.

Since much of the contamination at WSSRAP was liquid (sludge or water) and very mobile, the decision-makers did not consider removal and disposal to be sufficient, as the contaminants would likely seep into the ground and contaminate the nearby water and soil. As a result, remedial alternatives that did not involve treatment were eliminated. The decision-makers were aware that these alternatives would require an unnecessary and unreasonable burden on the use of long-term stewardship activities, “...more extensive monitoring and maintenance would be required to minimize potential long-term impacts because the disposal cell would contain untreated raffinate pit sludge.”[15]

Treatment alone was also not considered to be sufficient because treatment technologies did not render containments nonhazardous. Alternatives that included treatment but not disposal in an engineered cell were considered long-term liabilities because “of the difficulties in ensuring the successful implementation of [chemical stabilization]” and “uncertainties associated with the successful implementation of in-situ vitrification.” Containment in an engineered cell was considered important because “an engineered cell would reduce the potential for contaminant migration.”[16] Remedial alternatives that involved on-site stabilization or vitrification were screened out because they did not provide disposal for all contaminants in an engineered facility.

Alternatives that involved chemical stabilization/solidification and disposal off-site were screened out because they were not easily implementable. One side-effect of chemical stabilization/solidification is added weight and volume. This added bulk makes transportation to off-site facilities technically impracticable.[17]

Evaluation of Remaining Alternatives

The second phase of the decision-making process was the evaluation of these five alternatives in the Record of Decision, which yielded one final selected alternative that would become the remedial action at WSSRAP. This evaluation process was conducted using the nine CERCLA criteria outlined above.

Of the remaining five remedial alternatives, the only significant differences between them were:

- Method of treatment - either chemical stabilization or vitrification; and
- Disposal location - either on-site, at the Envirocare facility, or at the Hanford site.

In deciding between the remaining alternatives, thorough individual and comparative analyses using the CERCLA criteria were conducted. However, the final decision was based primarily upon two criteria: cost, and performance uncertainty. The selected remedy, which involved chemical stabilization and on-site disposal, was the least expensive and most reliable remedy available. The total cost (in constant dollars) for the selected remedy was $25-$194 million lower than the other alternatives,[18] and according to the ROD, "Off-site disposal alternatives do not offer an increase in effectiveness over the on-site disposal alternatives that can justify the greatly increased costs."[19]

In many instances, the decision-makers made it clear that technology reliability and predictability were important factors in their decision. "The uncertainties with regard to the performance and implementability of vitrification steered the decision toward a more demonstrated technology."[20]

The decision-making process was limited by the technology options that were available, and as a result, the final decision was more strongly influenced by technical reliability and predictability than any other criteria. The decision-makers chose to employ a reliable technology, and it benefitted long-term stewardship planning efforts by simplifying remedial actions and providing predictability to the long-term stewardship process.

Long-term stewardship would have been required for any remedy that was chosen, but it was significant that the screening process resulted in alternatives that combined removal, treatment, and disposal (engineered control) with long-term stewardship activities. Alternatives were required to have all three of these protective measures in order to maximize long-term protection of human health and the environment.

Long-Term Stewardship Considerations

Although the decision-making process was driven by technical and cost issues, decision-making documentation demonstrated that long-term stewardship issues were considered in the decision-making process. Post-Closure Monitoring and Maintenance was identified as an Applicable or Relevant and Appropriate Requirements (ARAR) under Resource Conservation and Recovery Act (RCRA), Uranium Mill Tailings Radiation Control Act (UMTRCA), and the Missouri Code of State Regulations. Groundwater Monitoring was also identified as an ARAR under RCRA, TSCA, and the Missouri Code of State Regulations.[21]

There are several instances where the decision-makers documented an understanding of the length of time waste management will be required. In the ROD, the decision-makers indicate that the selected remedy will not last forever or function risk-free, but the combination of engineered controls, treatment, and long-term stewardship activities (specifically monitoring and maintenance) will result in a sufficient long-term solution. The disposal cell that is required to be built under Alternatives 6a and 7a "would be designed to last at least 200 to 1,000 years, and regular monitoring and maintenance activities would be conducted to ensure long-term effectiveness into the foreseeable future."[22] This time frame for engineered cells is designated under UMTRCA,[23] but does not reflect the true lifetime of the waste. DOE recognized in the Record of Decision that "perpetual care will be taken of the committed land because the waste would retain its toxicity for thousands of years...the cover will be visually inspected, groundwater will be monitored, and the effectiveness of the overall system at the Weldon Spring site will be reviewed at least every five years."[24]

It was also stated in the ROD that "the required monitoring and five-year reviews will provide an effective precaution against any future potential release going undetected and resulting in actual exposure."[25] This statement is significant, because it demonstrates an awareness that any engineered remedy will fail, and releases will occur; however, if monitoring and maintenance efforts are diligent, these failures will be detected and remedied without threatening human health or the environment. Chapter 7.2 of the Feasibility Study includes another significant requirement - that long-term stewardship activities should be conducted until it is decided that they are no longer needed. "Maintenance activities would include [various activities] until such time as a joint decision was made by DOE and the appropriate regulatory agencies (the EPA and the state of Missouri) to discontinue that component of the monitoring and maintenance program."[26]

Long-term stewardship activities are also considered in total cost estimates for both on-site and off-site disposal alternatives. Cost estimates for Alternatives 6a, 7a, and 7c include costs for "long-term maintenance," which "includes environmental monitoring." In each estimate, $23.9 million dollars (accounting for 15 percent, 13 percent, and 8 percent of the total costs, respectively) were expected to be needed for the long-term care. The dollar amounts were the same because the estimates assumed that "long-term maintenance at the Hanford site [alternative 7c] are... the same as those for waste disposal at the Weldon Spring site under alternative 7a."[27] These allocations are also footnoted with the stipulation that the cost is only for a 30-year period. This short time frame does not reflect the expectations that are made elsewhere in the decision documents. If the cost estimates reflected the true long-term stewardship costs for the hundreds or thousands of years that the activities will be conducted, it would still probably not change the decision, because all of the alternatives are assumed to have similar requirements. However, having long-term stewardship cost estimates helps to define the expectations of decision-makers and funders.

IMPLICATIONS OF DECISION WITH REGARD TO LONG-TERM STEWARDSHIP

At present, most of the remedial action has been completed, and several of the long-term stewardship activities (e.g., groundwater and surface water monitoring) are already being conducted.[28] However, it is worthwhile to consider what long-term stewardship obligations were expected when the ROD was written, and then compare these with the actual long-term stewardship activities that are, or will be, conducted, as described in recent planning documents. This comparison is based on an analysis of the long-term stewardship plans as written in the

Long-Term Monitoring and Maintenance Plan[29], the *Institutional Controls Plan,*[30] and the *Stewardship Document for Operations and Maintenance.*[31]

According to the Feasibility Study and the Record of Decision, the following long-term stewardship activities were expected to be part of the selected remedy:

- Access controls (such as locking structures, etc.);
- Monitoring of groundwater and surface water;
- Maintaining groundwater monitoring system;
- Regular cell inspection;
- Operating leachate collection and removal system;
- Five-year reviews of the effectiveness of the remedy;
- Controlling runon and runoff; and
- Contingency vitrification treatment

In response to possible concerns over potential risk that an on-site disposal cell posed to the nearby populations, DOE agreed to several conditions to gain acceptance from the State of Missouri. Two of these conditions were 1) "No wastes from other sites shall be disposed of at the Weldon Spring site", and 2) "The DOE shall commit to long-term monitoring and maintenance of the disposal facility."[32] The first of these commitments was included in the Record of Decision. The second of these commitments was provided for in a series of long-term stewardship plans:

- *Institutional Controls Plan for the Weldon Spring Site*[33]
- *Weldon Spring Site Stewardship Document for Operations and Maintenance*[34]
- *Long-Term Monitoring and Maintenance Plan for the Weldon Spring Site*[35]

These plans were published (draft) in July-August, 2000, almost seven years after the decision was made for the Chemical Plant Area. These plans describe how long-term stewardship will be conducted. The attachment that follows this case study provides a further discussion of these plans, including how they were created and what they contain.

ATTACHMENT

THE WELDON SPRING SITE LONG-TERM STEWARDSHIP PLANNING PROCESS: PROCESS, CONSIDERATIONS, AND CONTENT

This section of the case study focuses on the long-term stewardship plan. Because the long-term stewardship plan provides guidance for the entire Weldon Spring Site, this section of the study discusses activities that will occur at all four of the operable units. It examines the elements, components as well as the process used to develop this plan. This section also highlights key considerations of a long-term stewardship plan and reviews activities already ongoing. This section of the case study also discusses the relationship between these documents and analyzes their relationship to other DOE documents.

Several documents were used to prepare this study. The *Stewardship Plan for the Weldon Spring Site*,[36] issued in April 1999, was the initial draft. This initial draft has been rewritten and separated into three documents, or volumes. Information for this case study is based on the three draft documents, produced in July-August 2000, which comprise the current (draft) Weldon Spring long-term stewardship plan. These documents are:

- *Weldon Spring Site Stewardship Document for the Operations and Maintenance (referred to as Site Stewardship Document)*[37]
- *Institutional Controls Plan for the Weldon Spring Site(referred to as IC Plan)*[38]
- *Long-term Monitoring and Maintenance Plan for the Weldon Spring Site (referred to as LTM&M Plan)*[39]

ATTRIBUTES OF THE WELDON SPRING LONG-TERM STEWARDSHIP PLAN

The *Stewardship Plan for the Weldon Spring Site*, April 1999, and the *Site Stewardship Document*, August 2000, specify three fundamental attributes: responsibility; long-term effectiveness; and adaptability. These attributes form the basis for the plan. Each document identifies a proposed steward. The proposed steward varies based on whether they are performing a principal, implementation, or oversight role and whether the function of that role is dependent on the federal or local government. There is one principal steward; the Department of Energy-Grand Junction Office (GJO) has primary responsibility for all legal actions, financial obligations and long-term monitoring and maintenance activities. However, other agencies have been proposed for other areas of long-term stewardship responsibility. The National Archives and Records Administration is proposed to be responsible for long-term archiving of records pertaining to long-term stewardship, and the St. Charles County Recorder of Deeds is proposed as having local responsibility for maintaining and preserving deeds, easements, and parcel maps.

Both the federal and the state government are proposed as oversight stewards. DOE is responsible for compliance with DOE orders and federal environmental regulations and EPA, Region VII is responsible for oversight. The state government is proposed oversight responsibility for compliance with state regulations. For example, the Missouri Department of Natural Resources, Division of Environmental Quality is responsible for overseeing that DOE is in compliance with state regulations, the Missouri Department of Health is proposed for public health issues, the Missouri Department of Conservation is proposed for overseeing access agreements for Department-owned property, and the Missouri Department of Natural Resources, State Parks Division is proposed for the access agreement for Katy Trail.

Some areas of the Weldon Spring Site such as the Borrow Area and haul roads, do not require long-term stewardship beyond record-keeping because residual contamination has been removed and the areas have been returned to the original property owners (i.e., the Missouri Department of Conservation or the Missouri Department of Natural Resources).

PREPARATION AND PROCESS

Preparation of the Weldon Spring Site long-term stewardship plan began in 1998. Although no official directive was in place to produce a long-term stewardship plan, site managers at the Weldon Spring Site recognized the need for such a plan. *The Oak Ridge Reservation Stakeholder Report on Stewardship (ORR Report),*[40] July 1998, was used as the primary template for the WSSRAP long-term stewardship plan. The *ORR Report* presents the attributes and basic elements of a long-term stewardship program; describes the existing and proposed statutory provisions for long-term stewardship and institutional controls; and presents recommendations for an Oak Ridge Reservation long-term stewardship program, including stewards, physical and institutional controls, information systems, research and funding options. Authors of the Weldon Spring Site long-term stewardship plan also used the long-term stewardship plans for the Grand Junction-site.[41] While the *ORR Report* and other documents were available for guidance, not all components were applicable to the Weldon Spring site.

The process for developing a long-term stewardship plan consisted of numerous meetings with the state and local citizens groups, primarily the Missouri Department of Natural Resources and the Weldon Spring Citizens Commission respectively. Stakeholders, identified from earlier initiatives of the project, were invited to provide input to the plan. Later in the process, it was decided that working group sessions would be a useful for gathering suggestions and input.[42]

CONTENT OF THE PLAN

The purpose of the long-term stewardship plan is to provide detailed information on long-term stewardship activities and responsibilities, monitoring and maintenance activities, corrective actions, and types of controls implemented as part of the final remedy. The plan also address the time frame, actions, and procedures for implementation. The Weldon Spring Site long-term stewardship plan is currently comprised of three volumes, although not numbered as volumes.

1. *Weldon Spring Site Stewardship Document for the Operations and Maintenance (Site Stewardship Document)*

2. *Institutional Controls Plan for the Weldon Spring Site (IC Plan)*

3. *Long-term Monitoring and Maintenance Plan for the Weldon Spring Site (LTM&M Plan)*

Stewardship Plan for the Weldon Spring Site, April 1999, Revision A

This plan was intended to be a working draft and was issued prior to the Final Groundwater Operable Unit ROD. This plan has been replaced with another draft, entitled *Weldon Spring Site Stewardship Document for Operation and Maintenance*. The April 1999 plan outlines the attributes and elements of long-term stewardship and provides a brief description of each site specific element (i.e., Southeast Drainage, Weldon Spring Quarry, Quarry Area Groundwater, Chemical Plant and Burgermeister Spring). This information details who maintains responsibility for the area and describes any institutional or physical controls that are required. The chemical plant area plan specifies that institutional controls consist of DOE permitting of land use/physical structures and that fencing, leachate sump, locking monitoring wells, and erosion control serve as the physical controls.

The *Stewardship Plan* (April 1999) has many similarities to the *Site Stewardship Document for Operations and Maintenance* (August 2000) as it is was the predecessor to the current plans written in July and August 2000. However, site specific elements featured in the initial *Stewardship Plan* have been replaced with the site history, a physical site description, and a description of the final site conditions. This was intended to provide a framework for the discussion of long-term stewardship. Because both documents have the same document control number, it is assumed the information has been updated and adds more detail to the long-term stewardship plan.

The Weldon Spring Site Stewardship Document for Operations and Maintenance August 2000, Revision 0

The is the first volume in a series of post-closure documents comprising the CERCLA-mandated operations and maintenance plan and replaces the April 1999 *Stewardship Plan for the Weldon Spring Site*. The purpose of the *Site Stewardship Document* is to provide the framework for implementing operations and maintenance activities for the lifetime of the disposal cell and monitoring and maintenance activities for the Chemical Plant and the Groundwater and Quarry Residuals Operable Units until protective levels as stipulated in the RODs are met. This volume of the plan describes the need for, and the basic elements of a long-term stewardship program; application to the DOE WSSRAP; roles and responsibilities of stakeholders; and public participation.

The *Site Stewardship Document* provides a physical description and site history for the Weldon Spring Site. In addition, a description of the final site conditions provides the basis for the long-term stewardship plan. This volume uses tables and flow charts to detail key components of the plan. Decision trees are used to identify the decision points where modification to the long-term stewardship plan will/can occur. Tables are used to identify the stewards and their respective functions. This volume of the plan assigns areas of responsibilities and lists the key activities involved in the long-term stewardship plan. Examples of the primary actions and decisions include:

- Conduct long-term monitoring activities;
- Review yearly data results;
- Reduce/increase sampling frequency;
- Determine if action levels have been exceeded;
- Implement Contingency Plans;
- Conduct a 5-year review;
- Determine if protective levels have been achieved;
- Revise long-term monitoring plan/institutional control plan; and
- Revise long-term stewardship plan

Revisions will occur periodically, based upon results obtained from monitoring efforts. It is assumed that these plans will require revision, and has been listed as a primary action.

The *Site Stewardship Document* identifies several activities that must be accomplished for successful implementation of a long-term stewardship plan. First, the authority and funding for long-term stewardship must be established as a primary function of program implementation. Second, stewards must be identified for the site and responsibilities must be assigned. Third, enforcement authority must be established. Finally, corrective actions and contingency plans must be included to address possible adverse effects.

The *Site Stewardship Document* also describes and provides examples for the six elements of the Weldon Spring Site operations. These elements and examples of such activities include:

1. **Monitoring:** Groundwater monitoring at the quarry and review of analytical data. DOE-GJO has primary responsibility for data interpretation and modification of sampling frequency.

2. **Maintenance:** Visual inspections of the disposal cell cover; inspection items will include evidence of erosion, intrusion by animals or plants, vandalism, and deterioration of rock cover or subsidence, periodic preventive maintenance.

3. **Surveillance:** Routine inspections and reporting will occur as specified in the long-term monitoring plans for the site. Institutional controls will be evaluated every 5 years to determine effectiveness.

4. **Enforcement:** The Environmental Protection Agency (EPA) and the Missouri Department of Natural Resources (MDNR) will ensure overall compliance with the ROD commitments and have been designated as the oversight stewards. Decisions for various response actions will be based on established action levels in the LTM&M plan.

5. **Inspection and Re-evaluation:** CERCLA 5-year reviews and annual environmental reports will evaluate the trends in groundwater contaminants.

6. **Public Participation:** Annual monitoring reports and 5-year reviews will be issued to provide public awareness of the site condition status. DOE has also established a site interpretive center to provide an avenue for ongoing public awareness of the site.

The six elements of long-term stewardship are also discussed, followed by a short summary on the intent of each section. The six elements of long-term stewardship are:

1. **Authority and funding** – must be established as a primary function of program implementation.

2. **Stewards** – must identify three categories of stewards: 1) principal stewards, 2) implementation stewards, and 3) oversight stewards.

3. **Operations** – includes the 6 categories as described above.

4. **Physical controls –** limit access to containments and exposure to hazards; physical controls used at the WSSRAP include engineered disposal cell, an enclosure around the leachate sump, signs, protective casings, posts, and locking caps on monitoring well structures, and erosion control features.

5. **Institutional controls** – legally binding provisions designed to provide assurance that land use will be compatible with long-term stewardship goals by limiting development and/or restricting access to a site with residual contamination; examples include easements, deed notices and restrictions, and site registries.

6. **Information systems –** includes development, maintenance and accessibility of documents and databases associated with the site.

A full discussion of these elements is contained in the other two volumes of the plan. For example, the *Site Stewardship Document* discusses the type, format and location of information systems, however, a detailed description of the database type and specific function appears in the *LTM&M Plan*.

This volume of the plan also specifies procedures for the maintenance of the long-term stewardship information systems. Duplicate sets of documents will be maintained at both the DOE-GJO and the site interpretive center. These documents will be preserved for a minimum of 10 years. The National Archives and Records Administration (NARA), Rocky Mountain National Archive Center will maintain all records identified for permanent storage.

The authors have also incorporated public participation into the *Site Stewardship Document*. This volume of the plan discusses the community and DOE contacts, as well as the document review and public meeting process. To ensure public participation occurs in periodic site reviews, DOE will send out a request for public interest in the annual environmental report. The *Site Stewardship Document* establishes a list of participants in the 5-year review process. This process will include DOE-GJO, EPA Region VII, Argonne National Laboratory (ANL), Missouri

Department of Natural Resources - Federal Facilities Section, St. Charles County, and the Weldon Spring Citizens Commission.

Long-Term Monitoring and Maintenance Plan for the Weldon Spring Site, Revision 0, August 2000

This document is the second volume in a series of post-closure documents comprising the CERCLA-mandated operations and maintenance plan for the Weldon Spring Site. The primary purpose of this document is to provide specific guidelines for conducting site inspections; erosion control, leachate management, and groundwater monitoring; quality assurance activities; and general site maintenance for the Weldon Spring site. The plan address both the post-closure monitoring period of 30 years, as specified in Title 40 CFR 264.310(b), and the 200-year monitoring period specified in Title 40 CFR 192.

The Long-Term Monitoring and Maintenance Plan for the Weldon Spring Site (LTM&M Plan) presents guidelines for long-term monitoring activities and inspection schedules for the Chemical Plant Operable Unit, the Groundwater Operable Unit, and the Quarry Residuals Operable Unit. Specifically, the plan includes the following chapters: final site conditions, chemical plant area site inspection, groundwater monitoring program, and Quarry Residual Operable Unit monitoring program. This volume of the plan addresses the applicable or relevant and appropriate requirements (ARARs) for post-closure monitoring and maintenance which have been identified in the RODs for each of the operable units. The plan states that because the Weldon Spring Quarry will be backfilled during restoration activities, long-term monitoring or maintenance activities are not required for this operable unit. Groundwater monitoring will be required for the Quarry Residuals Operable Unit. The plan provides the technical basis and schedules for monitoring, maintenance, and surveillance inspection activities. Long-term monitoring and maintenance plans include requirements for annual environmental monitoring reports as well as site inspection and maintenance activities.

The monitoring program for the Quarry Residual Operable Unit details the strategy, monitoring, parameters, frequencies, data analysis and interpretation. The plan also specifies the schedule and outlines the necessary elements of a disposal cell inspection and the Chemical Plant area site inspection. The plan describes the disposal cell design features including the cover, leachate collection sump, and erosion control features. This document also identifies specified corrective actions to address occurrences such as damage to the disposal cell cover, exceedance of baseline conditions in disposal cell monitoring wells, and the groundwater concentrations exceeding specified threshold values.

From the perspective of long-term monitoring and maintenance of overall disposal cell performance, the plan states that the two most important engineered control systems for the Chemical Plant Area are the 1) cover system and 2) the leachate collection sump. Other primary systems include: waste, clean-fill dike, geochemical barrier, basal liner system. The plan details the mechanisms for which these systems will be maintained through visual inspections and maintenance, and monitored. The plan states that inspection teams will conduct visual inspections annually for the first 5 years after closure. Inspection frequency will decrease as appropriate if no changes are evident. The site has been divided into three transects (i.e., disposal facility, site boundary, and outlying areas). Each of these areas comprises specific features for comprehensive inspection and reporting. The *LTM&M Plan* specifies what areas and features of concern should be included in the inspection for each transect. For example, inspection of the outlying areas should include off-site groundwater monitoring wells, commercial and residential development including outdoor recreation activities, headwater cutting erosion in local drainage basins, and evidence of roads and trails that may occur on or near the chemical plant area.

The *LTM&M Plan* also addressed the issue of as-built drawings, aerial maps and database systems which will be used to document physical site conditions or changes to the disposal cell, and that may be used to develop contingency plans. The plan details the aerial photography specifications to ensure all photographs taken of the site (regardless of time period) are easily comparable. The *LTM&M Plan* describes the database systems that will be transferred to the long-term monitoring program. These database systems include: geographic information systems (GIS), verified site analytical data, and the Borehole Master file.

This volume of the plan was written in June 2000, prior to final approval of the Groundwater Operable Unit ROD. Therefore, a placeholder has been left in the plan until the ROD is issued and the plan is revised. Any changes, such as the list of chemical parameters or the number of monitoring samples, will be reviewed prior to the plans becoming effective. Details regarding the implementation of the groundwater monitoring program will be developed and incorporated into this plan upon the finalization of the Groundwater Operable Unit ROD and subsequent Remedial Design/Remedial Action Work Plan for the Groundwater Operable Unit.

A chapter of the *LTM&M Plan* is dedicated to the Quarry Residual Operable Unit Monitoring Program. The plan summarizes the monitoring frequency, laboratory procedure requirements, and baseline values for groundwater chemical analysis for the Weldon Spring Site Monitoring Program. Long-term monitoring for this operable unit consists of groundwater monitoring uranium levels and contaminant levels within the area of groundwater impact, until a predetermined target level has been attained. Due to a difference in groundwater migration pathways, the monitoring strategies differ for north and south of the slough. Therefore, separate sections have been written for guidance in the interpretation of data.

The *LTM&M Plan* has also incorporated three chapters on the following areas:

Quality Assurance/Quality Control Requirements: This chapter states that a separate document, the *Environmental Quality Assurance Project Plan (EQAPjP),*[43] has been developed for the Weldon Spring site. The guidelines in this plan, intended to be followed by personnel conducting routine environmental data gathering operations, were prepared meet the applicable EPA requirements.

Contingency Plans: This chapter identifies occurrences that may require corrective action. Specific corrective actions are identified for the compliance wells and the disposal cell proper. In addition, several corrective action measures are required if the Action Leakage Rate (ALR) is exceeded. A summary of potential disposal cell failure scenarios and the appropriate response action is provided; decision-making steps for each scenario are also included. These scenarios include:

- Disposal cell biointrusion;
- Disposal cell settlement;
- Disposal cell surface erosion;
- Chemical plant surface erosion;
- Riprap degradation; and
- Change in the leachate collection and retention system sump

Portions of another contingency plan, the *Well Field Contingency Plan*,[44] are integrated into this plan. The *Well Field Contingency Plan* outlines contains contingency actions for construction of new wells and actions to take in the event an alternative drinking water source is needed.

Reporting and Record-keeping Requirements: Details the types of records and reports included in the permanent site files.

Institutional Controls Plan for the Weldon Spring Site, Revision 0, July 2000

This plan is the third volume in a series of post-closure documents comprising the CERCLA-mandated operations and maintenance plan. This volume of the plan identifies and describes the institutional controls that will be implemented at the Weldon Spring Site. Some sections of the plan, in particular for the Quarry Residuals Operable Unit, will be updated as the ROD is implemented. This volume presents a summary of the institutional controls, responsible parties, methods of implementation, and the purpose for each control and discusses the institutional controls for the Chemical Plant Operable Unit, the Groundwater Operable Unit, and the Quarry Residuals Operable Unit.

Both the Chemical Plant and the Quarry Residuals Operable Units specify long-term monitoring activities as a portion of the selected remedy. The final remedy for the Chemical Plant Operable Unit incorporates both engineered controls (waste treatment and construction of a disposal cell) and institutional controls. This volume states that some decisions pertinent to future use of the property are deferred until the final remedy for the Groundwater Operable Unit is determined.

The institutional controls include proprietary control (i.e., government ownership) and easement agreements (i.e., deed restrictions and access agreements). DOE will maintain proprietary control. For the disposal cell, this control is applicable “in perpetuity”, however for the outlying chemical plant property between the buffer zone and property boundary and the quarry proper, this control is based upon evaluation of the protectiveness of remedy in the CERCLA 5-year reviews. Easement agreements are anticipated to be the primary type of control for applicable vicinity properties. For example, the DOE will maintain an agreement with the Missouri Department of Conservation for the Southeast Drainage, which will impose restrictions on future land use so that no private development occurs within the drainage proper. Other vicinity properties have been remediated to acceptable risk levels and are not anticipated to require institutional controls.

Decisions regarding the type of institutional controls required for the Groundwater Operable Unit are pending, subject o the issuance of a final ROD. While the groundwater is not currently used and is not expected to be used in the foreseeable future, it is considered potentially useable based upon classification categories set by the EPA. Therefore, controls designed to restrict access to the groundwater for domestic usage are envisioned for this OU. The final decisions on controls for the Quarry Residuals OU are also based upon the implementation of the Quarry Residuals ROD. Basic controls anticipated at this location include prohibitions on extraction or collection of groundwater for consumption or irrigation purposes. The DOE will also maintain access agreements with the NDC for groundwater monitoring and monitoring well maintenance and repair activities.

Physical controls at the WSSRAP consist of the engineered disposal facility, an enclosure around the leachate pump, signs, protective groundwater well casings, posts, and locking caps on monitoring well structures, and erosion control features. Although physical controls are often thought of in context with institutional controls, physical controls are included in the *LT&M Plan*.

INTEGRATION OF OTHER DOE DOCUMENTS

Prior to the development of the Weldon Spring Site long-term stewardship document, DOE had developed other related documents for a variety of site remediation activities. Currently, several of these documents are used for operations and maintenance activities for the operable units and outlying areas. While these documents are referenced in the long-term stewardship plan, they exist as separate documents. Once site remediation operations cease and the long-term stewardship commences, these documents may become integrated into the long-term stewardship plan as additional plans or volumes. These documents provide valuable supplemental information to the long-term stewardship plan. Examples of such documents include:

- *Administrative Record File System Management Plan,*[45] Revision 3 (April 1998) - identifies what information is retained and for how long it is retained.

- *Weldon Spring Disposal Cell Groundwater Monitoring Plan,*[46] Revision 0 (September 1996) - establishes the baseline conditions for the monitoring wells and discusses the preferred method for data comparisons.

- *Well Field Contingency Plan,*[47] Revision 1 (November 1992) - details the monitoring and contingency actions for the well field.

- *WSSRAP Disposal Cell Monitoring Well Program Installation Report,*[48] Revision 0 (February 1997*)* - contains the borelogs, construction details, and information on hydraulic conductivity for each monitoring well.

- *Environmental Quality Assurance Project Plan (EQAPjP),*[49] Revision 4 (October 199) - developed by the Weldon Spring Site to meet the applicable requirements of EPA; establishes QA/QC guidelines for activities involving the acquisition, analysis, and evaluation of environmental data.

According to the Weldon Spring Site long-term stewardship plan, additions will be made to the *Record of Completed Actions*[50] throughout the remainder of the remediation project. This document will not only provide a comprehensive discussion of previous site conditions and final remediation activities, it will also provide important historical perspective.

ON-GOING ACTIVITIES THAT WILL CONTINUE DURING LONG-TERM STEWARDSHIP

It is expected that several of the activities, currently being performed at the Weldon Spring Site will continue in the stewardship phase. Such activities include:

- Monitoring of groundwater and surface water;
- Maintaining groundwater monitoring system;
- Annual environmental reports;
- Inspection of in-place physical controls;
- Management of administrative records;
- Inspection and maintenance of access controls; and
- Regular cell inspection

According to the Feasibility Study and Record of Decision for the Chemical Plant Area, the above activities have been designated as remedies. Therefore, since these activities are currently ongoing, and will continue as the Weldon Spring Site moves into long-term stewardship, elements of the currently existing plans for these activities have been incorporated into the long-term stewardship plan.

The Feasibility Study and Record of Decision for the Chemical Waste Plant has also designated activities in the proposed remedy that are currently on-going. However, as the remediation ends and the stewardship begins, these activities will become necessary and thus, have been incorporated into the current long-term stewardship plan. Such activities include:

- Operating leachate collection and removal system;
- 5-year reviews of the effectiveness of the remedy and reports ;
- Mowing the vegetative cover;
- Controlling run on and runoff;
- Contingency plans; and
- Inspections of newly created/built physical controls (e.g., disposal cell cover)

KEY CONSIDERATIONS

The authors of the Weldon Spring Site long-term stewardship document identified several key points during the plan development.[51] Some of the key considerations are outlined below:

Roles and Responsibilities. The long-term stewardship plan defines roles and responsibilities for long-term stewardship activities for the Weldon Spring Site, including responsibility for institutional and physical controls. The plan identifies the roles and responsibilities for DOE and external entities.

Document Enforcement. There is no enforceable requirement for the creation of a long-term stewardship plan. Therefore, the authors decided to base the plan on the activities which have been required by CERCLA. Based on the fact that the CERCLA Record of Decision stipulated engineering and institutional controls are part of the remedy, the CERCLA 5-year review process for the operable units provided this important link. If certain elements of the Stewardship Plan are beyond the scope of CERCLA, an alternative enforcement mechanism will be necessary.

Format. The document was originally packaged as a single document. The authors eventually decided to package the document into three separate sections or volumes. The first of the three sections serves as an "umbrella document", while two supplemental documents contain the technical information of the plan (i.e, long-term monitoring and maintenance and institutional controls). The authors believed this would simplify the modification process.

Stakeholder participation. Public involvement is a key component of long-term stewardship plans. The identification of stakeholders for production of the plan was not an issue because the site already had established relationships with local citizen groups and state and local government officials and had established stakeholders as part of the CERCLA process. Examples of stakeholders include surrounding land owners, Department of Defense, local representatives, and members of the local school district. The site stewardship plan specifically states their areas of involvement. Furthermore, it was indicated that the participation of stakeholders had the potential to influence existing long-term stewardship goals. For example, the frequency of reporting requirements for CERCLA reports is every 5 years. Local citizens expressed concern that 5 years was not frequent enough, especially once the site enters the stewardship phase.

The Weldon Spring Site managers have also adopted an approach used by the Grand Junction-site. DOE has made plans to lease the administration building to the school district for use as administration offices. This initiative not only allows for the integration and assistance of a local stakeholder, but keeps an existing presence on the site.

Document preparation and updates. An early start to the process of preparing a long-term stewardship plan will allow for adequate public participation and time to finalize the plan before the stewardship phase begins. In the case of the Weldon Spring Site, the process to develop a long-term stewardship plan began in 1998; seven years after the decision to build a disposal cell. The estimated time for disposal cell completion is 2002. At the time the plan was initiated, the Record of Decision for the Groundwater Operable Unit had not been released. Therefore, several gaps exist in plan and will require finalization. The authors acknowledge that the plan will require an update when final groundwater cleanup levels are established and cleanup data is gathered and accessed.

The key component of a long-term plan is flexibility because each portion of the plan is subject to many revisions. Prior to the development of any long-term stewardship plan, the issue of funding and appropriations must be addressed. This is essential since the roles and responsibilities for the plan are based on funding. It is anticipated that items, such as the distribution list and notification numbers, will require modification on an annual, if not biannual basis.

Time perspective. The preliminary verison of the *Stewardship Plan for the Weldon Spring Site*, April 1999, stated that the plan was written from the FY2002 perspective (i.e., site closure) and contained assumptions that certain schedules activities have been completed (i.e. demolition of Building 434, removal of off-site haul road, and necessary access agreements finalized between agencies). However, this statement no longer exists in the June 2000 version. Long-term stewardship plans are written from the perspective that they will be implemented during the stewardship phase, even though activities such as groundwater monitoring may have been ongoing for years, prior to the stewardship phase.

ENDNOTES

1. stlouis.missouri.org/citygov/planning/research/data/about/population/pop.htm

2. ROD for Remedial Action at the Chemical Plant Area, pg. 19.

3. ROD for the Remedial Action at the Chemical Plant Area, pg. 4.

4. www.em.doe.gov/wssrap/cleanup.html#Engineered Disposal Facility.

5. ROD for the Remedial Action at the Chemical Plant Area, pgs. 47-49.

6. ROD for the Remedial Action at the Chemical Waste Plant, pg. 1.

7. Feasibility Study for the Remedial Action at the Chemical Waste Plant.

8. Feasibility Study for Remedial Action at the Chemical Waste Plant, pg. 5-2.

9. Feasibility Study for the Remedial Action at the Chemical Waste Plant, pg. 5-24.

10. Feasibility Study for the Remedial Action at the Chemical Waste Plant, pg. 5-39.

11. Feasibility Study for the Remedial Action at the Chemical Waste Plant, p.5-45.

12. Feasibility Study for the Remedial Action at the Chemical Waste Plant, p.4-2.

13. Feasibility Study for the Remedial Action at the Chemical Waste Plant, pg. 4-19.

14. ROD for the Remedial Action at the Chemical Waste Plant, pg. 64.

15. Feasibility Study for the Remedial Action at the Chemical Waste Plant, pg.4-32.

16. Feasibility Study for the Remedial Action at the Chemical Waste Plant, pg.4-21.

17. Feasibility Study for The Remedial Action at the Chemical Waste Plant, pg. 4-37.

18. Feasibility Study for the Remedial Action at the Chemical Waste Plant, tables 6.7, 6.8, 6.11, and 6.14.

19. Record of Decision for the Remedial Action at the Chemical Waste Plant, pg. 111.

20. Record of Decision for the Remedial Action at the Chemical Waste Plant, pg. 68.

21. Record of Decision for the Remedial Action at the Chemical Waste Plant, pg. 103.

22. Feasibility Study for the Remedial Action at the Chemical Waste Plant, pg. 7-17.

23. Code of Federal Regulations, Uranium Mill Tailings Radiation Control Act of 1978, 40 CFR 192.32, November 15, 1993.

24. Record of Decision for the Remedial Action at the Chemical Waste Plant, pg. 112.

25. Record of Decision for the Remedial Action at the Chemical Waste Plant, pg..68.

26. Feasibility Study for the Remedial Action at the Chemical Waste Plant, pg. 7-17.

27. Feasibility Study for the Remedial Action at the Chemical Waste Plant, tables 6.7, 6.8, 6.11, and 6.14.

28. Record of Decision for the Remedial Action at the Chemical Waste Plant, pg. 48.

29. Long-term Monitoring and Maintenance Plan for the Weldon Spring Site, August 2000.

30. Institutional Controls Plan for the Weldon Spring Site, July, 2000.

31. Weldon Spring Site Stewardship Document for Operations and Maintenance, August, 2000.

32. Record of Decision for the Remedial Action at the Chemical Waste Plant, pgs..71-72.

33. Institutional Controls Plan for the Weldon Spring Site, July, 2000.

34. Weldon Spring Site Stewardship Document for Operations and Maintenance, August, 2000.

35. Long-term Monitoring and Maintenance Plan for the Weldon Spring Site, August 2000.

36. MK-Ferguson Company and Jacobs Engineering Group. *Stewardship Plan for the Weldon Spring Site*, DOE/OR/21548-771, Revision A, Prepared for the U.S. Department of Energy, Oak Ridge Operations Office, St. Charles, MO, Weldon Spring Site Remedial Action Project. April 1999.

37. MK-Ferguson Company and Jacobs Engineering Group. *Weldon Spring Site Stewardship Document for Operations and Maintenance*, DOE/OR/21548-771, Revision 0, Prepared for the U.S. Department of Energy, Oak Ridge Operations Office, St. Charles, MO, Weldon Spring Site Remedial Action Project. August 2000.

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41. Pauling, Tom. Environmental Engineer, Weldon Spring Site Remedial Action Project, phone conversation, November 7, 2000.

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45. MK-Ferguson Company and Jacobs Engineering Group. *Administrative Record File System Management Plan*, Revision 3, DOE/OR/21548-344, Prepared for the U.S. Department of Energy, Oak Ridge Field Office. St. Charles, MO. April 1998.

46. MK-Ferguson Company and Jacobs Engineering Group. *Weldon Spring Disposal Cell Groundwater Monitoring Plan*, Revision 0, DOE/OR/2158-646. Prepared for the U.S. Department of Energy, Oak Ridge Operations Office. St. Charles, MO, September 1996.

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48. MK-Environmental Services. *WSSRAP Disposal Cell Monitoring Well Program Installation Report, Task 786.* Technical Memorandum No. 3840TM-7220-0. Rev. 0, Prepared for the U.S. Department of Energy, Oak Ridge Field Office. St. Charles, MO. February 1997.

49. MK-Ferguson Company and Jacobs Engineering Group, *Environmental Quality Assurance Project Plan (EQAPjP)*. Rev. 4. DOE/OR21548-352. Prepared for the U.S. Department of Energy, Oak Ridge Operations Office. St. Charles, MO, October 1999.

50. *Record of Completed Actions*. DOE/OR/21548-688. Owned by B Goldkamp, is in ongoing preparation and will be added to through the remainder of the project. This document is held in a limited access folder.

51. Pauling, Tom. Environmental Engineer, Weldon Spring Site Remedial Action Project, phone conversation, November 7, 2000.

APPENDIX F

TREATMENT AND DISPOSAL OF DOE'S LOW-LEVEL RADIOACTIVE WASTE AND MIXED LOW-LEVEL RADIOACTIVE WASTE

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TREATMENT AND DISPOSAL OF DOE'S LOW-LEVEL RADIOACTIVE WASTE AND MIXED LOW-LEVEL RADIOACTIVE WASTE

INTRODUCTION

In May 1997, the Department of Energy (DOE) issued the *Final Waste Management Programmatic Environmental Impact Statement* (WM PEIS) for treatment, storage, and disposal of radioactive and hazardous waste (DOE/EIS-0200-F). The Final WM PEIS examined the environmental impacts of managing more than two million cubic meters of radioactive wastes from past, present, and future DOE activities. The WM PEIS will assist DOE in improving the efficiency and reliability of managing its current and anticipated volumes of radioactive and hazardous wastes and will help DOE continue to comply with all applicable laws and regulations and ensure the protection of workers, public health, and the environment.[1]

The WM PEIS analyzed low-level radioactive waste (LLW), mixed low-level radioactive waste (MLLW), high-level radioactive waste (HLW), and transuranic waste (TRU), and non-wastewater hazardous waste generated by defense and research activities at 54 sites. Four Records of Decision (RODs) resulted from this WM PEIS: TRU ROD (63 FR 3629, Jan. 23, 1998); non-wastewater hazardous waste ROD (63 FR 41810, Aug. 5, 1998); HLW ROD (64 FR 46661, Aug. 26, 1999); and LLW and MLLW ROD (65 FR 10061, Feb. 25, 2000).

This case study examines only the portion of the WM PEIS and the associated Record of Decision (ROD) that focus on the treatment and disposal of low-level radioactive waste (LLW) and mixed low-level radioactive waste (MLLW). This study discusses how DOE evaluated the long-term stewardship (LTS) consequences associated with DOE's treatment and disposal options for LLW and MLLW. This study includes a description of the decisions, the alternatives considered, and the decision-making criteria, and evaluates the extent to which long-term stewardship needs and costs were considered in the decision-making process. The study also identifies the implications of the decisions with respect to long-term stewardship, specifically whether the decisions created more extensive long-term stewardship obligations and costs for the DOE that could have been avoided.

DESCRIPTION OF PROJECT

LLW is defined as "all radioactive waste not classified as high-level waste, transuranic waste, spent nuclear fuel, or by-product tailings containing uranium or thorium from processed ore (as defined in Section 11(e)2 of the Atomic Energy Act of 1954 [42 U.S.C. 2011 et seq.]) and not classified hazardous waste under the Resource Conservation and Recovery Act (RCRA). Since the World War II Manhattan Project, DOE and its predecessor agencies have generated LLW from a variety of activities; including weapons production, nuclear reactor operations, environmental restoration activities, and research."[2] MLLW contains hazardous and low-level radioactive components. The hazardous components in MLLW are subject to RCRA, whereas the radioactive components are subject to the Atomic Energy Act.[3] DOE has generated MLLW as a result of research, development, and production of nuclear weapons, and environmental restoration activities.[4]

For the management of LLW analyzed in the WM PEIS, DOE decided to perform minimum treatment at all sites and continue, to the extent practicable, disposal of on-site LLW at the Idaho National Engineering and Environmental Laboratory (INEEL), the Los Alamos National Laboratory (LANL), the Oak Ridge Reservation (ORR), and the Savannah River Site (SRS). In addition, DOE decided to make the Hanford Site and the Nevada Test Site (NTS) available to all DOE sites for LLW disposal. INEEL and SRS will continue to dispose of LLW generated by the Naval Nuclear Propulsion Program.[5] DOE decided to treat MLLW at the Hanford Site, INEEL, ORR and SRS, and to dispose of MLLW at Hanford and the NTS.

ALTERNATIVES CONSIDERED

The WM PEIS defined an alternative as the configuration of sites for treating, storing, and/or disposing of a specific waste type. The alternatives considered in the WM PEIS and the Record of Decision were comprised of two variables: method of treatment, and disposal location(s). Four general categories of dismissed locations were considered (Exhibit 1).

Exhibit 1. Dismissed Options for LLW and MLLW

No Action	Involves using only currently existing waste management facilities at DOE sites or commercial vendors. Storage of MLLW would continue at DOE sites indefinitely.
Decentralized	Involves treating and disposing of waste where it is generated or already located. Decentralized alternatives may require the siting, construction, and operation of new facilities or the modification of existing facilities.
Regionalized	Involves transporting waste to a small number of sites for treatment and disposal. In general, the sites with the largest volumes of a given waste type were considered as the regional sites for treatment and disposal.
Centralized	Involves transporting wastes to one site for disposal. Treatment may occur at more than one site. As in the case of the regionalized alternatives, the sites with the largest volumes of a given waste type were considered for centralized treatment, storage, and disposal.

Commercial or private entities could potentially be used within each of these categories. Furthermore, DOE's options are not limited to one of the above four alternatives, but can be a hybrid alternative that would incorporate actions from one or more of the four alternatives. There are many possible combinations of the number and location of sites under each of the above alternatives. For purposes of the Final WM PEIS, these possible combinations were narrowed down to representative alternatives under each category. Exhibits 2 and 3 summarize the specific alternatives analyzed for MLLW and LLW, respectively:

Exhibit 2 – MLLW Alternatives evaluated in the Final WM PEIS

Alternative	# of Disposal Sites	# of Treatment Sites	Disposal Sites	Treatment Sites
No Action	0	3	None	INEL, ORR, SRS
Decentralized	16	37	ANL-E, BNL, FEMP, Hanford, INEEL, LANL, LLNL, NTS, ORR, PGDP, Pantex, PORTS, RFETS, SNL-NM, SRS, WVDP	All 37 sites with mixed low-level waste
Regionalized 1	12	11	FEMP, Hanford, INEL, LANL, LLNL, NTS, ORR, PGDP, Pantex, PORTS, RFETS, SRS	FEMP, Hanford, INEL, LANL, LLNL, ORR, PGDP, Pantex, PORTS, RFETS, SRS
Regionalized 2	6	7	Hanford, INEL, LANL, NTS, ORR, SRS	Hanford, INEL, LANL, ORR, PORTS, RFETS, SRS
Regionalized 3	1	7	NTS	Hanford, INEL, LANL, ORR, PORTS, RFETS, SRS
Regionalized 4	6	4	Hanford, INEL, LANL, NTS, ORR, SRS	Hanford, INEL, ORR, SRS
Centralized	1	1	Hanford	Hanford

Exhibit 3 - LLW Alternatives evaluated in the Final WM PEIS

Alternative	# of Disposal Sites	# of Treatment Sites	Disposal Sites	Treatment Sites
No Action	6	10	Hanford, INEL, LANL, NTS, ORR, SRS	Hanford, INEL, LLNL, ORR, PGDP, RFETS, SRS, LBL, RMI, Mound
Decentralized	16	0	ANL-E, BNL, FEMP, Hanford, INEL, LANL, LLNL, NTS, ORR, PGDP, Pantex, PORTS, RFETS, SNL-NM, SRS, WVDP	
Regionalized 1	12	0	FEMP, Hanford, INEL, LANL, LLNL, NTS, ORR, PGDP, Pantex, PORTS, RFETS, SRS	

Exhibit 3 - LLW Alternatives evaluated in the Final WM PEIS				
Alternative	**# of Disposal Sites**	**# of Treatment Sites**	**Disposal Sites**	**Treatment Sites**
Regionalized 2	12	11	FEMP, Hanford, INEL, LANL, LLNL, NTS, ORR, PGDP, Pantex, PORTS, RFETS, SRS	FEMP, Hanford, INEL, LANL, LLNL, ORR, PGDP, Pantex, PORTS, RFETS, SRS
Regionalized 3	6	0	Hanford, INEL, LANL, NTS, ORR, SRS	
Regionalized 4	6	7	Hanford, INEL, LANL, NTS, ORR, SRS	Hanford, INEL, LANL, ORR, PORTS, RFETS, SRS
Regionalized 5	6	4	Hanford, INEL, LANL, NTS, ORR, SRS	Hanford, INEL, ORR, SRS
Regionalized 6	2	0	Hanford, SRS	
Regionalized 7	2	0	NTS, SRS	
Centralized 1	1	0	Hanford	
Centralized 2	1	0	NTS	
Centralized 3	1	7	Hanford	Hanford, INEL, LANL, ORR, PORTS, RFETS, SRS
Centralized 4	1	7	NTS	Hanford, INEL, LANL, ORR, PORTS, RFETS, SRS
Centralized 5	1	1	Hanford	Hanford

Preferred Alternative for Mixed Low-Level Waste: The preferred alternative in the identified in the Final WMPEIS[6] was a hybrid alternative that differed from any of the identified alternatives in Exhibit 2:

1. *Treatment* – For any sites that did not have on-site waste treatment facilities, waste was to be treated at Hanford, INEEL, ORR, or SRS. For any sites that did have appropriate facilities, treatment could be conducted on-site.

2. *Disposal* – Waste would be disposed of at either the Hanford Site or the Nevada Test Site.[7]

Preferred Alternative for Low-Level Waste: The preferred alternative identified in the Final WM PEIS[8] was a combination of the identified decentralized alternative for treatment, and a new regionalized alternative for disposal:

1. *Treatment* – Waste would be treated on-site at each site.

2. *Disposal* – Waste would be disposed of at two or three sites, to be determined after consultations with stakeholders.

The preferred alternative identified in the *Notice of Preferred Alternatives* published by DOE on December 10, 1999 was the disposal of low-level waste at the Hanford Site and the Nevada Test Site.

DECISION-MAKING CRITERIA

Exhibit 4 lists the factors and criteria that were used in the Final WM PEIS (pg.1-51) to select preferred alternatives:

Exhibit 4. Factors and Criteria used in assessing Alternatives in the Final WM PEIS

Factor	Criteria
Consistency	Alternatives should be consistent with other complex-wide studies using methodologies that allow valid comparisons across sites.
Cost	Alternatives are favored if they have the potential to minimize overall cost for implementation of selected waste management strategies.
Cumulative Impacts	Alternatives should minimize cumulative adverse environmental impacts resulting from other activities at the site.
DOE Mission	Alternatives should further the Department's mission to safely and efficiently treat, store, and ultimately dispose of waste.
Economic Dislocation	Alternatives are favored if they tend to minimize economic dislocation such as job losses.
Environmental Impact	Alternatives should minimize adverse environmental impacts.
Equity	Alternatives are favored if they distribute waste management facilities in ways that are considered equitable.
Human Health Risk	Alternatives should reduce human health risk to both workers and the public. Human health risks depend upon the magnitude of releases of radionuclides and hazardous chemicals, population surrounding sites, the hydrogeology of disposal sites, and the number of vehicle accidents that are expected to occur during transportation of waste.
Implementation Flexibility	Alternatives are favored if they maximize DOE's ability to modify activities as circumstances change.
Mitigation	Alternatives that increase DOE's ability to mitigate adverse impacts and that reduce the cost of mitigation are favorable.

Factor	Criteria
Regulatory Compliance	Alternatives must comply with regulatory requirements, DOE Orders, and commitments made under the FFCAct or in compliance agreements with States and other regulators.
Regulatory Risk	Consideration is given to the potential for changes in statutes and regulations.
Site Mission	Alternatives are favored if they are consistent with site capabilities, particularly capacities and availability of technologies for treatment, storage, and disposal.
Transportation	Alternatives should balance the amount of transportation needed to transport waste to the site with the potential environmental and human health risks, vehicle accidents, public concerns, mission needs, and costs.

Four criteria that were cited in the *Basis for Decision* sections of the Record of Decision, and seemed to have the most impact on the decision-making process include the following[9]:

1. *Operational Flexibility* - Alternatives were selected because they provided maximum flexibility for treatment and disposal of MLLW and LLW.

2. *Cost* - The treatment and disposal alternatives that were selected had relatively low implementation costs, and avoided unnecessary costs.

3. *Impacts to Human Health* - The selected alternatives minimized adverse impacts to human health (for workers and the public).

4. *Environmental Impacts* - The selected remedies did not impose unnecessary or exceptional environmental impacts.

DECISIONS DERIVED FROM THE WM PEIS

LLW Treatment

The Department decided to implement the preferred alternative specified in the Final WM PEIS for the treatment of LLW. Under this decision, each site will perform minimum treatment of its LLW, although each site may perform additional treatment as would be useful to decrease overall costs. This decision does not preclude DOE's use of commercial treatment facilities, consistent with current DOE orders and policy.

DOE decided to pursue minimum treatment as its overall strategy for LLW treatment because volume reduction of LLW would not offer sufficient benefits to offset the increase in human health effects and costs it would entail. All DOE sites with LLW must perform at least minimum treatment on all of their LLW, regardless of whether the waste is further treated using volume reduction methods. A programmatic volume reduction treatment strategy would pose greater worker hazards, because workers would be exposed to risks from additional treatment processes.

The analyses did not demonstrate that these more immediate worker risks would be offset by corresponding long-term human health or environmental risk reduction due to volume reduction. Volume reduction also could pose additional transportation impacts; because not all sites have volume reduction treatment facilities, some LLW would have to be shipped for treatment. Finally, volume reduction would cost twice as much as minimum treatment, and the increased treatment costs generally would not be offset by potential savings from disposing of less waste or other benefits.

LLW Disposal

The Department decided to establish regional LLW disposal at two DOE sites: the Hanford Site and NTS. Specifically, the Hanford Site and NTS will each dispose of its own LLW on-site, and will receive and dispose of LLW that is generated and shipped (by either truck or rail) by other sites that meets the waste acceptance criteria. In addition, DOE will continue, to the extent practicable, disposal of on-site LLW at INEEL, LANL, ORR, and SRS. INEEL and SRS also will continue to dispose of LLW generated by the Naval Nuclear Propulsion Program.

The LLW disposal decision in the ROD is the preferred alternative that DOE announced in the December 1999 Notice discussed above. Under this decision, DOE will implement a combination of the preferred LLW disposal alternative identified in the Final WM PEIS (i.e., regionalized disposal at two DOE sites – the Hanford Site and NTS) and the Decentralized Alternative (disposal of on-site generated LLW at four sites – INEEL, LANL, ORR, and SRS).

MLLW Treatment

DOE decided to implement the Preferred Alternative specified in the Final WM PEIS for the treatment of MLLW. DOE will conduct regional MLLW treatment at the Hanford Site, INEEL, ORR, and SRS, or on-site, as would be consistent with current Site Treatment Plans. Current Site Treatment Plans were negotiated among DOE, the host state, and/or the Environmental Protection Agency under the Federal Facility Compliance Act, and may undergo periodic renegotiation.[10]

MLLW Disposal

The Department's decision is to establish regional MLLW disposal operations at two DOE sites: the Hanford Site and NTS. The Hanford Site and NTS will each dispose of its own MLLW on-site, and will receive and dispose of MLLW generated and shipped (by truck or rail) by other sites, consistent with permit conditions and other applicable requirements.

C0NSIDERATION OF LONG-TERM STEWARDSHIP ISSUES IN DOE'S DECISION-MAKING

From the documentation available, DOE considered to varying degrees the following potential long-term stewardship issues in its decision-making:

1. *Life-cycle costs*. Life-cycle costs, including D&D costs, specifically, facility decontamination and demolition, closure, post-closure, and environmental monitoring activities. According to the Final WM PEIS (Tables 6.14-2 and 7.14-2), life-cycle costs and D&D costs are highest for the decentralized alternative, and they get lower as a function of centralization, with the centralized options having the lowest D&D costs.

2. *Risks to a hypothetical intruder 100 years and 300 years after disposal facility closure*. According to the Final WM PEIS (Tables 6.16-1 and 7.4-12), in both the 100- and 300-year scenario, the risks were greatest for the decentralized alternative and least for the centralized alternative. For every alternative, the risk was higher in the 100-year scenario than the 300-year scenario. These risks assume that institutional controls are no longer active, and the intruder uses well water from the site and also uses the land for agriculture.

3. *Post-closure groundwater quality*. According to the Final WM PEIS (Table 7.6-3), the decentralized alternative would result in the greatest number of sites (7) with poor groundwater quality; the regionalized alternatives would result in 1-3 sites with poor groundwater quality, and the centralized alternatives would result in 0-1 sites with poor groundwater quality.

4. *Land Use and Acreage*. In the Final WM PEIS (Table 7.11-2), the centralized alternatives would require the least amount of land, and the decentralized and regionalized alternatives would require the most amount of land.

CONCLUSION

The available documentation indicates that the life-cycle cost analysis did not take into account the long-term care and maintenance if the treatment and disposal facilities in the post-closure phase. Costs were presented reflecting the total life-cycle cost estimates by waste-type alternatives. Costs were estimated using an approach that tied the cost of facilities and transportation to waste quantities. In addition, DOE used costs associated with existing technologies and historical industrial cost experience for estimating purposes. The Final WM PEIS considers a 20-year waste management period to estimate such costs.

The available documentation does not explicitly indicate how the decision-making process for the disposal and treatment of low-level waste and mixed low-level waste considered long-term stewardship issues. Long-term stewardship needs and costs were not identified or evaluated in the decision documents for the alternatives, and therefore potential differences in the long-term stewardship characteristics of the alternatives cannot be addressed fully in this study. It is not clear from the available documentation how the decision-making process evaluated the entire proposed program with respect to long-term stewardship.

ENDNOTES

1.Overview of the Final Waste Management Programmatic Environmental Impact Statement. *http://www.em.doe.gov:80/peisfs/overview.html*

2.*Record of Decision for the Department of Energy's Waste Management Program: Treatment and Disposal of Low-Level Waste and Mixed Low-Level Waste; Amendment of the Record of Decision for the Nevada Test Site*. Federal Register, Volume 65, Number 38. Friday, February 25, 2000. *http://www.em.doe.gov/em30/llwrod.html*

3.Overview of the Final Waste Management Programmatic Environmental Impact Statement. *http://www.em.doe.gov:80/peisfs/overview.html*

4.*Record of Decision for the Department of Energy's Waste Management Program: Treatment and Disposal of Low-Level Waste and Mixed Low-Level Waste; Amendment of the Record of Decision for the Nevada Test Site*. Federal Register, Volume 65, Number 38. Friday, February *http://www.em.doe.gov/em30/llwrod.html*

5.Ibid

6.Final Waste Management Programmatic Environmental Impact Statement (WM PEIS) for treatment, storage, and disposal of radioactive and hazardous waste (DOE/EIS-0200-F).

7. Notice of Preferred Alternatives. Federal Refister. Vol. 64. No. 237. Friday, December 10, 1999.

8.Final Waste Management Programmatic Environmental Impact Statement (WM PEIS) for treatment, storage, and disposal of radioactive and hazardous waste (DOE/EIS-0200-F).

9. *Record of Decision for the Department of Energy's Waste Management Program: Treatment and Disposal of Low-Level Waste and Mixed Low-Level Waste; Amendment of the Record of Decision for the Nevada Test Site*. Federal Register, Volume 65, Number 38. Friday, February 25, 2000. *http://www.em.doe.gov/em30/llwrod.html*

10.Overview of the Final Waste Management Programmatic Environmental Impact Statement. *http://www.em.doe.gov:80/peisfs/overview.html*

APPENDIX G

TRITIUM SUPPLY AND RECYCLING PROGRAM

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TRITIUM SUPPLY AND RECYCLING PROGRAM

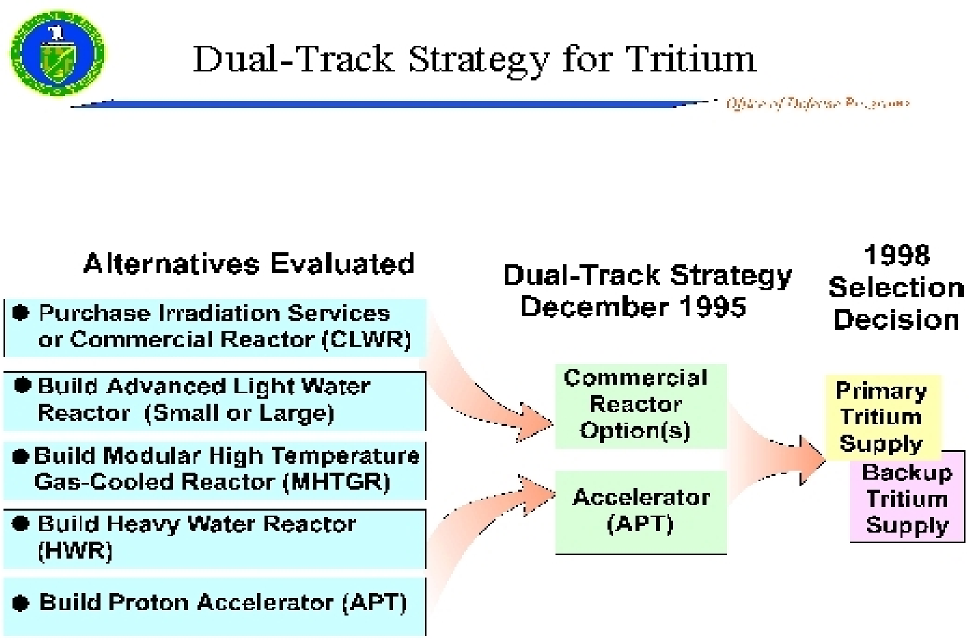
INTRODUCTION

Tritium is a radioactive isotope of hydrogen and an essential component of every warhead in the current and projected U.S. nuclear weapons stockpile. Tritium's relatively short radioactive half-life (12 years) necessitates the periodic replenishment of tritium in nuclear weapons to ensure that they will function as designed. Pursuant to the Atomic Energy Act of 1954, the Department of Energy (DOE) is responsible for developing and maintaining the capability to produce the nuclear materials, such as tritium, that are necessary for the defense of the United States (40 U.S.C. 2011). Over the past 40 years, DOE has built and operated more than a dozen nuclear reactors, five of them at the Savannah River Site (SRS), to produce tritium and other nuclear materials for weapons purposes. DOE stopped producing new tritium in 1988, when the last government-owned nuclear materials production reactor at SRS was shut down. Since 1988, DOE has been recycling tritium from dismantled weapons to meet national security requirements. However, due to the relatively rapid decay of tritium, the President has mandated the establishment of a new source by around the year 2005.

SUMMARY DESCRIPTION OF DOE's TRITIUM SUPPLY AND RECYCLING STRATEGY AND DECISION-MAKING PROCESS

DOE evaluated the programmatic need for a new tritium source in the *Programmatic Environmental Impact Statement (PEIS) for Tritium Supply and Recycling* (DOE/EIS-01621) published in October 1995. The Tritium Supply and Recycling PEIS assessed the potential environmental impacts of technology and siting alternatives for the production of tritium for national security purposes, as well as the impacts of constructing a new Tritium Extraction Facility (TEF) at SRS. Based on the findings in that PEIS and other technical, cost, and schedule evaluations, DOE issued a Record of Decision (ROD) on December 5, 1995 (60 FR 63878). In the ROD, DOE decided to pursue the two most promising tritium supply alternatives in a dual-track approach (see Figure 1): (1) purchase an existing (operating or partially complete) commercial light water reactor (CLWR) or purchase irradiation services from a commercial light water reactor; and (2) design, build, and test critical components of an accelerator system for tritium production. Furthermore, SRS H Area was selected in the 1995 ROD as the location for an accelerator for production of tritium (APT), should one be built. The exact location of the TEF at SRS would be decided after issuance of a site-specific Environmental Impact Statement. A TEF must be operated in conjunction with a CLWR to ensure the proper extraction of tritium. However, a TEF would not be required for the APT alternative. Under the dual-track strategy, it was expected that, within 3 years, one of the two technologies would be selected as the primary tritium supply technology and the other technology, if feasible, would be developed as a back-up tritium source, should the primary source not be able to fulfill tritium stockpile capacity requirements.

Figure 1



On December 22, 1998, DOE announced that commercial light water reactors (CLWRs) would be used as the primary source of tritium.[5] The Accelerator Production of Tritium (APT) project would continue to be pursued as a back-up tritium source, but an APT would be constructed only if the CLWR (i.e., the primary option) could not fulfill tritium stockpile capacity requirements. Subsequently, three site-specific Environmental Impact Statements (EISs) were issued in March 1999 regarding: (1) production of tritium in a CLWR; (2) construction and operation of a TEF at SRS; and (3) accelerator production of tritium at SRS Use of a CLWR as the primary tritium supply option would require the construction of a TEF, however, an APT would not require a TEF to produce tritium. Subsequently, on May 6, 1999, DOE issued the Consolidated ROD for Tritium Supply and Recycling (64 FR 26369.) This decision established that the mission of the CLWR Project is to develop by 2003 the production capability and operations systems necessary to produce tritium in a commercial reactor so that tritium can be delivered to meet stockpile requirements. The Consolidated ROD documented the basis for the December 22, 1998 decision and instituted several other decisions: (1) the Tennessee Valley Authority's (TVA) Watts Bar Unit 1 and Sequoyah Unit 1 and Sequoyah Unit 2 reactors are the specific CLWRs that will provide irradiation services for tritium supply; (2) the location for a new TEF is the H-Area at SRS; and (3) SRS was chosen as the location of an APT, if one is built, and various other technologies required to develop the accelerator as a back-up to the CLWR. This three-part decision launched DOE's plan for a new domestic source of tritium to support the stockpile.

The Consolidated Record of Decision includes the following decisions based on their associated environmental impact statements:

1. *Site-specific Decision for the Production of Tritium in a Commercial Light Water Reactor*. Selects the Tennessee Valley Authority's (TVA) existing and operating Watts Bar Unit 1, Sequoyah Unit 1, and Sequoyah Unit 2 reactors for use in irradiating tritium-producing burnable absorber rods (TPBARs). This decision is tiered from and implements the supplemental programmatic decision described above. Environmental analysis is contained in the *Final EIS for the Production of Tritium in a Commercial Light Water Reactor*[1]. This EIS is tiered from the *Tritium Supply and Recycling PEIS*.

2. *Site-specific Decision for Construction and Operation of a Tritium Extraction Facility at the Savannah River Site*. Selects the alternative that would design, construct, test, and operate a new TEF in the H-Area immediately adjacent to and west of Building 233-H at the Savannah River Site. This facility is an essential element of the system for producing tritium using TPBARS irradiated in commercial reactors. This decision is tiered from and implements the supplemental programmatic decision described above. Environmental analysis is contained in the *Final EIS for Construction and Operation of a TEF at the Savannah River Site*[2] which is tiered from the *Tritium Supply and Recycling PEIS*.

3. *Site-specific Decision for the Accelerator Production of Tritium (APT)*. Selects the specific location at the Savannah River Site and the technologies to be used for the backup tritium supply technology, should its construction be required. This decision is tiered from and implements the supplemental programmatic decision described above. Environmental analysis is contained in the *Final EIS for Accelerator Production of Tritium*[3] (DOE/EIS-0270, March 1999) which is tiered from the PEIS.

Analysis of Long-Term Stewardship Considerations in DOE's Decision-Making

The chronology of the decision documents for the tritium supply and recycling program is summarized in the Attachment to this case study, which discusses each decision document, alternatives considered, alternative evaluation and decision-making criteria, and the decision derived from each decision document. The decision documents summarized in Attachment A do not explicitly address long-term stewardship issues, and long-term stewardship needs and costs were not identified in the decision documents or used as criteria in the decision-making process. The following decision-making criteria indirectly addressed long-term stewardship considerations for the tritium supply and recycling program:

Irreversible and Irretrievable Commitment of Resources. The alternatives considered for tritium supply and recycling varied with respect to the amount of land that needed to be committed to the program, and with respect to whether the land and associated facilities committed to the tritium supply and recycling program are already subject to long-term stewardship requirements. DOE considered utilizing an existing CLWR for tritium production, completing construction of a partially-completed CLWR, and producing tritium in an accelerator, among other alternatives. DOE also considered constructing a new TEF for tritium extraction and refurbishing for tritium extraction an existing off-site facility that was originally constructed for the purposes of spent fuel reprocessing.

The existing CLWRs considered for tritium production are already subject to long-term stewardship requirements under the terms of their NRC licenses. Therefore, in selecting existing CLWRs as the primary tritium production option, no substantial new long-term stewardship needs and costs were created, and no substantial amount of new land was committed to tritium production. Had DOE decided to complete construction of a partially-completed CLWR or build a new tritium production reactor, DOE would have created new long-term stewardship needs and costs for the newly completed reactor, in addition to existing long-term stewardship needs and costs for the existing CLWRs.[1] A decision to utilize a partially-completed CLWR also would have committed new land to tritium production, land that is currently occupied by a partially-completed reactor facility (presumably this facility is subject to long-term stewardship, however long-term stewardship requirements for a completed reactor are much more substantial than long-term stewardship requirements for a partially completed reactor.) A decision to construct a new production reactor for tritium would have committed new land to tritium production, land that is currently unoccupied.[2] Therefore, the decision to utilize the existing CLWRs for tritium production appears to minimize the long-term stewardship needs and costs associated with tritium production.

DOE avoided creating additional long-term stewardship needs and costs by selecting the existing CLWRs for production of tritium, rather than completing construction of an existing reactor or constructing a new reactor. DOE also could have minimized its own obligations for long-term stewardship by selecting the APT as the primary tritium source. Long-term stewardship needs and costs would exist for the existing CLWRs regardless of DOE's decision on tritium supply, however these would not necessarily be DOE responsibilities. Had DOE selected the APT as the primary tritium source, DOE could have avoided the need to construct a TEF and would have had long-term stewardship responsibilities for only the single APT facility, rather than for the existing CLWRs (if purchased by DOE) and the newly-constructed TEF. Because long-term stewardship needs and costs for the alternatives are not identified in the decision documents, no conclusion can be reached concerning whether the CLWR option or the APT option has lower long-term stewardship costs.

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[1] Long-term stewardship requirements for the existing CLWRs are the responsibility of TVA, while long-term stewardship requirements for a newly-constructed reactor for tritium production would be DOE obligations. Both would be responsibilities of the Federal Government. If the DOE <u>purchased</u> the existing CLWRs from TVA, presumably DOE would become responsible for long-term stewardship for these reactors. However, if DOE purchases irradiation services from TVA, presumably TVA would retain responsibility for long-term stewardship for the CLWRs under the terms of their existing licenses.

[2] It would be expected that a new production reactor or a new TEF would be constructed on SRS land that is already impacted from existing SRS operations that would require access restrictions and other long-term stewardship activities regardless of whether any new facility was constructed on the land.

Existing and new land commitments for tritium supply and extraction alternatives are summarized in the table below:

Existing and New Land Commitments for Tritium Supply and Extraction Alternatives

Alternative	Existing (Watts Bar + Sequoyah) CLWR	New TEF	Existing CLWR (Watts Bar + Sequoyah) plus new TEF	New CLWR (Bellefonte) plus new TEF	APT (without a new TEF)
Existing land commitment (acres)		0			0
New land committed (acres)	5.3 - 5.47			5 (CLWR) + ? (TEF)	250
Total land committed (acres)	5.3 - 5.47	0			250

Generation of High-Level and Low-Level Radioactive Wastes requiring Long-term Stewardship. The alternatives considered for tritium supply and extraction vary with respect to the volume of high-level and low-level radioactive wastes generated. Radioactive waste generation rates for the tritium supply and extraction alternatives are summarized in the table below:

Radioactive Waste Generation for Tritium Supply and Extraction Alternatives

Waste Type	Existing CLWR (Watts Bar + Sequoyah)		New TEF	Existing CLWR (Watts Bar + Sequoyah) plus new TEF		New CLWR (Bellefonte) plus new TEF	APT (without a new TEF)
	low rate	high rate		low rate	high rate		
HLW (m^3/yr)	no add. spent fuel assemblies if <2,000 TPBARS irradiated in 18 mth-cycle	Upto 60 add. spent fuel assemblies if 3,400 TPBARS irradiated in 18 mth-cycle	0	0	0	141 spent fuel assemblies / 18 mth cycle	0

Waste Type	Existing CLWR (Watts Bar + Sequoyah)		New TEF	Existing CLWR (Watts Bar + Sequoyah) plus new TEF		New CLWR (Bellefonte) plus new TEF	APT (without a new TEF)
	low rate	high rate		low rate	high rate		
LLW (m^3/yr)	0.43		233	233.43		271	1,400
MLLW (m^3/yr)			3.3			<1	

The decision to produce tritium in the existing CLWRs and a new TEF increases the volume of radioactive waste generated above the volume that would be generated if the APT were used for tritium production. APT would not generate spent fuel assemblies or other high level waste, however the existing CLWRs would generate spent fuel assemblies whether or not they are used for tritium production. However, depending upon the TPBAR irradiation rate, the existing CLWRs could generate up to 60 additional spent fuel assemblies every 18 months. Production of tritium in a newly constructed or newly completed CLWR would generate an even greater number of spent fuel assemblies. Therefore selection of the existing CLWRs for tritium production (at a low production rate) or selection of the APT minimizes the production of spent fuel assemblies and the associated long-term stewardship needs for the spent fuel assemblies. Disposal and long-term stewardship for the spent fuel would be the responsibility of DOE.

Low level radioactive waste generation at the existing Watts Bar and Sequoyah reactors could increase from current levels by 0.43 cubic meters annually as a result of tritium production. The exact volume of LLW for the CLWR option is not available in the decision documents. The partially completed reactor (i.e., Bellefonte) option would generate approximately 40 cubic meters of LLW annually. The impact of disposing of the additional LLW generated by each of the alternatives at the Barnwell commercial disposal facility at South Carolina would represent much less than 1 percent of the total LLW that is currently disposed of at the Barnwell facility. Long-term stewardship for this LLW would be the responsibility of the commercial disposal facility under the terms of the NRC license for the facility.

The APT (without tritium extraction capabilities) would generate approximately 1,400 cubic meters of LLW annually, while the TEF would generate 9,300 cubic meters of LLW. The total volume of LLW generated by the existing CLWRs and the TEF would be substantially greater than that generated by the APT. LLW generated by the TEF or the APT would be managed using the existing waste management treatment, storage, and disposal facilities at SRS, and long-term stewardship for waste disposed of on the SRS site would be the responsibility of DOE. The environmental impacts of all waste types for all alternatives, including LLW, would be small and manageable with existing SRS facilities. Although all of the waste generation impacts were found to be acceptable in the decision documents, the APT would generate the smallest amount of LLW from tritium production (and thereby minimize long-term stewardship needs and costs for the LLW), as opposed to the CLWR or the incomplete reactor alternatives..

Life-Cycle Costs. The APT and TEF would be designed to operate for 40 years, and the cost estimates provided in the EISs for the alternatives are based on a 40-year facility operating life. A new CLWR or completed CLWR for tritium production would also be licensed for a 40 year period, and it is anticipated that the modified Watts Bar/Sequoyah Reactors would be issued 40 year licenses after the tritium production modifications. Cost estimates for these alternatives are also based on a 40 year operating life. Life-cycle cost is defined in the decision documents to include investment cost, operating costs, and decontamination and decommissioning (D&D) costs for 40 years of the facility's life. However, none of the cost estimates for the alternatives consider the cost of post-closure and long-term stewardship activities. In addition, the available documents to not indicate how DOE's decision-making processes considered the cost of production of raw materials that would be used in the APT or CLWR options or disposal or long-term stewardship of wastes that would be generated by these options.

Human Health and Environmental Impacts. The decision-making analyses indirectly identified characteristics of the alternatives that are relevant to long-term stewardship. For example, DOE considered as one alternative for tritium extraction refurbishing and reusing an existing off-site facility that was originally designed for spent fuel recycling, in addition to another alternative to construct a new TEF in SRS H-Area. The decision documents identified as a primary difference between these alternatives the proximity of the off-site AGNS facility to non-government owned land and the greater potential for impacts to off-site individuals due to releases near the site boundary. The proximity of the AGNS facility to non-government land would also complicate the D&D and long-term stewardship requirements for the refurbished AGNS facility after facility operations are completed, although this issue was not addressed in the decision documents. The H-Area site is roughly in the center of the SRS, making application of access restrictions and land use controls that may be required after D&D of the facility is completed less difficult than applying such controls to non-government land adjacent to the AGNS site.

Also, the APT does not employ fissile materials in the production of tritium, unlike the CLWR and other production reactor options. The decision documents identifies as a principal difference between the APT option and the other options that because the APT does not utilize fissile materials the radiological consequences of APT facility accidents are insignificant as compared to that for the CLWR options. It may also be the case that the APT option would also require less extensive long-term stewardship activities than the CLWR options because there would be no fissile materials or high-level radioactive waste to be managed for the APT option, although this issue is not addressed directly in the decision documents.

Decision Analysis of Alternatives. The tritium production and tritium extraction portions of the proposed action were not analyzed as part of the same decision document even though both are part of the same overall mission. Production of tritium in an existing or new CLWR requires operation of a TEF to extract the tritium from the TPBARs irradiated in the CLWR. Selection of the CLWR option as the primary source of tritium leads to selection of the TEF as the tritium extraction option. The APT alternative, however, does not require operation of a TEF, as tritium extraction could be conducted in the existing SRS Tritium Loading Facility.

The CLWR EIS has a section pertaining to the TEF (Section 5.3.4 – Impacts at the Tritium Extraction Facility) which summarizes the results of the Final TEF EIS, but the CLWR EIS fails to indicate how DOE considered the *overall*, *cumulative* impacts of construction, operation, D&D, and long-term stewardship for the CLWR and the TEF. The APT alternative only involves a single facility for production of tritium, while CLWR irradiation involves both the modified reactor and the TEF.

Furthermore, available documentation does not indicate whether the APT alternative *with* tritium extraction capabilities incorporated into the design was analyzed as a viable option. Under current specifications, the APT will be built *without* tritium extraction capabilities since the SRS Tritium Loading Facility would be used for tritium extraction and recycling purposes.

CONCLUSIONS

The available documentation does not indicate how the decision-making process for the tritium supply and recycling program considered the long-term stewardship issues. Long-term stewardship needs and costs were not identified or evaluated in the decision documents for the alternatives, and therefore potential differences in the long-term stewardship characteristics of the alternatives cannot be addressed fully in this study. It appears that based on the decision criteria described in Attachment A that long-term stewardship concerns would have little impact on the selection of the existing CLWRs and new TEF as the primary option for production of tritium.

It is not clear from the available documentation how the decision-making process evaluated the entire proposed program with respect to long-term stewardship, including the production of raw materials and management of wastes for each alternative. It may be the case that long-term stewardship needs and costs for an alternative affected the design of an alternative or the methodology by which the alternative would be implemented, even if long-term stewardship issues did not directly affect the selection of the alternative.

ATTACHMENT

CHRONOLOGY OF THE DECISION-MAKING PROCESS FOR TRITIUM SUPPLY AND RECYCLING

The following sections chronologically present the various decisions that encompass DOE's tritium supply and recycling strategy and decision-making process:

October 1995

The *Final Programmatic Environmental Impact Statement (PEIS) for Tritium Supply and Recycling*[4] evaluated the siting, construction, and operation of tritium supply technology alternatives and recycling facilities at each of five candidate sites: the Idaho National Engineering and Environmental Laboratory (INEEL), the Nevada Test Site (NTS), the Oak Ridge Reservation (ORR), the Pantex Plant, and the Savannah River Site (SRS). A "No Action" alternative, i.e., DOE would not establish a new tritium supply capability, was also evaluated. Along with these siting options, the PEIS evaluated the use of five proposed technologies, i.e., the Heavy Water Reactor (HWR), Modular High Temperature Gas-Cooled Reactor (MHTGR), Advanced Light Water Reactor (ALWR), Commercial Light Water Reactor (CLWR) and Accelerator Production of Tritium (APT). Based on this PEIS and cost, schedule, and technical analyses, DOE narrowed down its preferred alternative to two promising production alternatives: (1) purchase an existing commercial light water reactor or irradiation services with an option to purchase the reactor for conversion to a defense facility; and (2) design, build, and test critical components of an accelerator system for tritium production. It was decided that within a three-year period, DOE would select one of the alternatives to serve as the primary tritium source and the other alternative would be developed as a secondary/back-up tritium source, should the primary source not be able to fulfill tritium capacity requirements.

December 5, 1995

The *Record of Decision: Selection of Tritium Supply Technology and Siting of Tritium Supply and Recycling Facilities* (60 FR 63878) listed the DOE's three simultaneous decisions. First, the Department will pursue a dual-track strategy on the two most promising tritium supply alternatives: to initiate purchase of an existing (i.e., operating or partially complete) commercial reactor or purchase of irradiation services from an existing reactor with an option to purchase the reactor for conversion to a defense facility; and to design, build, and test critical components of an accelerator system for tritium production. Within a three-year period, the Department would select one of the two technologies to serve as the primary source of tritium. The other alternative, if feasible, would be developed as a back-up tritium source. Second, the Savannah River Site (SRS) was selected as the location for an accelerator, should one be built. Third, the tritium recycling facilities at the SRS will be upgraded and consolidated to provide tritium recycling in support of both of the dual-track options. If the commercial reactor alternative is selected as the primary source, a tritium extraction facility will also need to be constructed. The

APT alternative would not require the construction of a TEF because tritium extraction can be carried out at the Tritium Loading Facility at the SRS, or the APT can be built with tritium extraction capabilities. The exact location of the TEF within the SRS would be determined on the basis of a site-specific EIS. The environmental analysis to support this decision was issued by the Department in the *Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling* DOE/EIS-0161 (October 1995). The PEIS identified the dual-track strategy described above as the preferred technology alternative. The Savannah River Site was identified as the preferred site for an accelerator, and the site for the upgrade and consolidation of existing recycling facilities.

December 22, 1998

In a press release, the Secretary of Energy announced that to ensure the safety, security, and reliability of the stockpile in the future, he had selected the Tennessee Valley Authority's (TVA) Watts Bar and Sequoyah reactors as the preferred facilities for producing a future supply of tritium and that the Savannah River Site would be the preferred facility to disassemble plutonium pits from weapons being taken out of the stockpile. Secretary Richardson's decision followed an extensive review of the regulatory, cost, proliferation, environmental, technical and national security issues associated with each option. The Secretary's announcement fulfilled the Department's 1995 commitment to select between a Commercial Light Water Reactor and a linear accelerator as the primary source of tritium by the end of 1998. Consistent with the Department's dual-track strategy for tritium production, the linear accelerator option has been designated as a backup technology. The Department will complete key research and development milestones for the accelerator, but will not complete construction of an accelerator unless the primary CLWR option fails to fulfill tritium stockpile capacity requirements.

March 1999

Three site-specific EISs were issued in March 1999: *Final Environmental Impact Statement for the Production of Tritium in a Commercial Light Water Reactor* (DOE/EIS-0288); *Final Environmental Impact Statement: Construction and Operation of a Tritium Extraction Facility at the Savannah River Site* (DOE/EIS-0271); and *Final Environmental Impact Statement: Accelerator Production of Tritium at the Savannah River Site* (DOE/EIS-0270). The findings of each of these EISs are discussed in detail in the sections below.

May 6, 1999

The *Consolidated Record of Decision for Tritium Supply and Recycling* (64 FR 26369, May 6, 1999) documented the December 22, 1998 announcement by the Secretary of Energy where he selected the commercial light water reactor alternative as the primary tritium source. The Consolidated ROD announced a three-part series of tiered decisions which, taken together, comprise the Department's plans for establishing a new domestic source of tritium to support the nuclear weapons stockpile. Each decision results from the preparation of a related environmental impact statement (EIS). In the order presented, this Consolidated Record of Decision makes the following decisions based on their associated environmental impact statements:

1. *Site-specific Decision for the Production of Tritium in a Commercial Light Water Reactor*. Selects the Tennessee Valley Authority's (TVA) existing and operating Watts Bar Unit 1, Sequoyah Unit 1, and Sequoyah Unit 2 reactors for use in irradiating tritium-producing burnable absorber rods (TPBARs). This decision is tiered from and implements the supplemental programmatic decision described above. Environmental analysis is contained in the *Final EIS for the Production of Tritium in a Commercial Light Water Reactor* (DOE/EIS-0288, March 1999). This EIS is tiered from the *Tritium Supply and Recycling PEIS*.

2. *Site-specific Decision for Construction and Operation of a Tritium Extraction Facility at the Savannah River Site*. Selects the alternative that would design, construct, test, and operate a new TEF in the H-Area immediately adjacent to and west of Building 233-H at the Savannah River Site. This facility is an essential element of the system for producing tritium using TPBARS irradiated in commercial reactors. This decision is tiered from and implements the supplemental programmatic decision described above. Environmental analysis is contained in the *Final EIS for Construction and Operation of a TEF at the Savannah River Site* (DOE/EIS-0271, March 1999) which is tiered from the *Tritium Supply and Recycling PEIS.*

3. *Site-specific Decision for the Accelerator Production of Tritium (APT)*. Selects the specific location at the Savannah River Site and the technologies to be used for the backup tritium supply technology, should its construction be required. This decision is tiered from and implements the supplemental programmatic decision described above. Environmental analysis is contained in the *Final EIS for Accelerator Production of Tritium* (DOE/EIS-0270, March 1999) which is tiered from the PEIS.

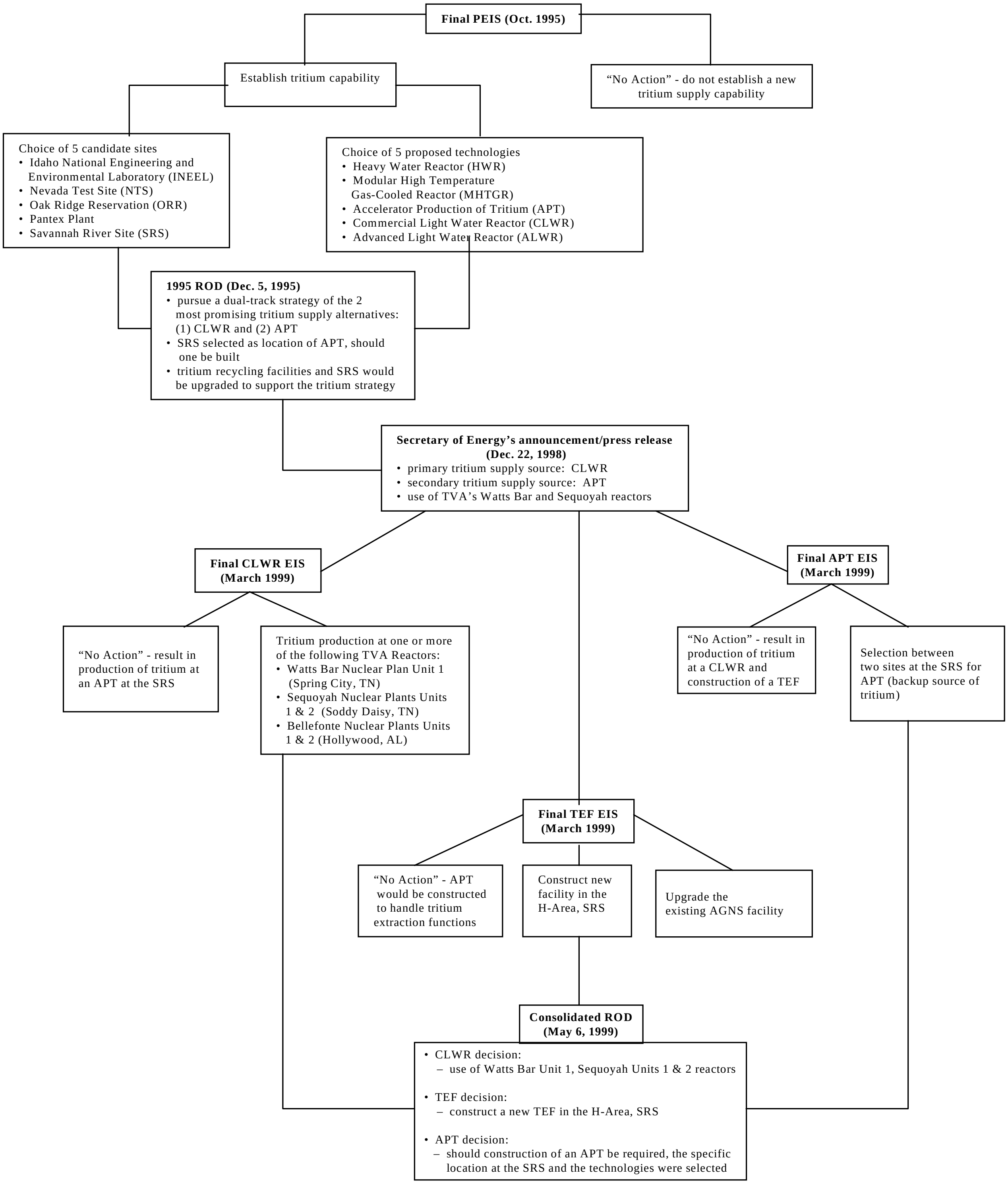
The draft decision-tree below is a compilation of the various decision steps that encompass DOE's tritium strategy. In the following sections, this case study will analyze these decisions and their implications for DOE's long-term stewardship obligations. This study includes a description of the decision(s), the alternatives considered, and the decision-making criteria, and evaluates the extent to which long-term stewardship needs and costs were considered in the decision-making process. The study also identifies the implications of the decision(s) with respect to long-term stewardship, specifically whether the decision(s) created more extensive long-term stewardship obligations and costs for the DOE that could have been avoided.

Final Programmatic Environmental Impact Statement

Alternatives Considered in the Final PEIS

The Final PEIS (*Final Programmatic Environmental Impact Statement (PEIS) for Tritium Supply and Recycling* (DOE/EIS-0161)) analyzed the use of five candidate sites: Idaho National Engineering and Environmental Laboratory (INEEL), Nevada Test Site (NTS), Oak Ridge

DRAFT DECISION-TREE



Reservation (ORR), Pantex Plant, Savannah River Site (SRS), and the "No Action" alternative, i.e., DOE would not establish a new tritium supply capability. The PEIS also analyzed the use of five proposed technologies, i.e., the Heavy Water Reactor (HWR), Modular High Temperature Gas-Cooled Reactor (MHTGR), Advanced Light Water Reactor (ALWR), Accelerator Production of Tritium (APT), and Commercial Light Water Reactor (CLWR) to support the tritium strategy. Each of the tritium supply technologies and site alternatives considered above, except for those located at the SRS, would need a new tritium recycling facility to be either co-located along with the facility, or else DOE would need to upgrade and then operate the existing tritium recycling facilities at SRS.

Decision-making Criteria

The Final PEIS presented both qualitative and quantitative comparisons among the various site and technology alternatives. The PEIS concluded that there were no major differences in the environmental impacts among the tritium supply technology and site alternatives for the following criteria: land resources, air quality, water resources, geology and soils, biotic resources, and socioeconomics. However, for other resource areas evaluated in the PEIS, the analyses indicated that there are notable environmental impact differences. These other areas include site infrastructure (electrical requirements), human health effects (from radiological impacts due to accidents), and wastes generated during operation.

1. *Site Infrastructure*: Infrastructure and electrical capacity exist at each of the alternative sites to adequately support any of the tritium supply technology alternatives. The ALWR and MHTGR technologies would generate electricity while also producing tritium, while the APT, and to a significantly lesser degree, the HWR, would be energy-consumers. Thus, in terms of environmental impacts, there could be approximately 1,800 MWe of difference in electricity generation (i.e., ALWR generating 1,300 MWe versus an APT consuming 500 MWe) between the tritium supply technologies. For existing commercial reactors that produce electrical power, there would be no change to the existing electrical infrastructure from production of tritium in the reactors.[6]

2. *Human Health Impacts*: The potential human health impacts from accidents are directly related to the amount of radioactivity released and the population density near the facility. The probability of a severe accident occurring is estimated to be in the order of once every million years at the most for each of the technology alternatives. An accident at the ALWR would cause the largest potential impacts to human health from severe accidents, while an accident at the MHTGR would have the smallest potential impacts. The APT does not utilize fissile materials and thus, there is no significant decay heat, resulting in virtually no radiological consequences from accidents. The CLWR alternatives do not have increased human health impacts from assuming tritium-production missions. INEEL, NTS, and to a lesser extent, Pantex Plant, have smaller human populations surrounding the sites, thus resulting in lesser human health impacts. Conversely, ORR and SRS have larger populations within 50 miles of the proposed facilities and would result in greater human health impacts in case of accidental exposures. There are virtually no radiological consequences from the APT alternative.

3. *Generated Wastes*: All of the technologies would generate spent reactor fuel, except for the APT alternative. The MHTGR would generate the greatest volume of spent reactor fuel. The heavy metal content of spent fuel from the ALWR would be the greatest. CLWRs would not generate additional spent fuel over and above what they would normally generate during their planned lifetime, assuming that multiple reactors are used and the operating scenarios do not change fuel cycles. The APT is not a reactor and thus, would not generate spent fuel. HWR would generate the most low-level waste per year (almost five times as much as any other reactor alternative). The APT would produce the least amount of low-level waste annually. All the sites, except for the Pantex Plant, are capable of handling low-level waste. Low-level waste from the Pantex Plant would need to be shipped off-site for processing and disposal.

Decision Derived from the Final PEIS

The decisions from the Final PEIS were announced in the December 5, 1995 *Record of Decision: Selection of Tritium Supply Technology and Siting of Tritium Supply and Recycling Facilities* (60 FR 63878). The three-tiered decision was as follows: (1) pursue a dual-track strategy on the two most promising tritium supply alternatives: to initiate purchase of an existing (i.e., operating or partially complete) CLWR or purchase irradiation services from an existing CLWR, with an option to purchase the reactor for conversion to a defense facility; and to design, build, and test critical components of an accelerator system (APT) for tritium production; (2) SRS selected to be the location for an APT, should one be built; and (3) tritium recycling facilities at the SRS will be upgraded and consolidated to support both of the dual-track options.

Commercial Light Water Reactor (CLWR) Project

Alternatives Considered in the Final CLWR EIS

The CLWR EIS (*Final Environmental Impact Statement for the Production of Tritium in a Commercial Light Water Reactor* (DOE/EIS-0288)) evaluated the following alternatives: (1) "No Action" alternative (which would result in the production of tritium in an accelerator (APT) at the SRS, instead of tritium production in a CLWR); and (2) tritium production at one or more of the following Tennessee Valley Authority (TVA) CLWRs: Watts Bar Nuclear Plant Unit 1 (Spring City, TN); Sequoyah Nuclear Plants Units 1 and 2 (Soddy Daisy, TN); and Bellefonte Nuclear Plants Units 1 and 2 (Hollywood, AL). The Watts Bar and Sequoyah reactors are existing, operating CLWRs that produce electricity. Tritium production could be performed in these reactors without any significant modifications to these facilities and would not affect electricity production. The Bellefonte units are unfinished nuclear reactors. Bellefonte Unit 1 is approximately 90 percent complete, and Bellefonte Unit 2 is approximately 58 percent complete. In order to produce tritium in a Bellefonte reactor, construction would have to be completed and an operating license would have to be received from the NRC.

Decision-Making Criteria

The CLWR EIS provided information on environmental factors only. Cost, schedule, and technical analyses were discussed in the Consolidated ROD. Several factors were used to assess the effectiveness of each tritium supply alternative in meeting the tritium stockpile capacity requirements. The factors or decision-making criteria relevant to long-term stewardship are presented below as discussed in both the EIS and the ROD.

1. *Cost*: Investment cost is defined as the total of all remaining (FY 1999-2008) up-front capital costs necessary to design, develop, construct, startup, or otherwise establish tritium production capacity at each of the CLWRs. Life-cycle cost is defined as the total amount of money spent to produce about 100 kilograms of tritium over the life of each reactor. Life-cycle cost includes investment cost, all operating costs, and decontamination and decommissioning (D&D) costs. All costs are calculated based on constant FY 1999 dollars for an assumed 40-year lifespan of these reactor facilities and do not include long-term stewardship costs. The Watts Bar/Sequoyah alternative has the lowest investment cost. There is also strong potential for the Watts Bar/Sequoyah option to have the lowest life-cycle cost because of the likelihood that Bellefonte (i.e., reactors that still need to be completed) life-cycle costs would be near the high end of the range of cost estimates. In addition, the Watts Bar/Sequoyah alternative has a significantly lower financial risk because DOE would not pay any costs until tritium is produced since the reactors are already operational. With the Bellefonte alternative there is a degree of risk that, having paid for the plant, DOE would not receive any return from net power revenues because of changes in the power market or failure of the reactor to go into operation. The cost of the "No Action" (APT) alternative is presented in the section covering the APT EIS below.

2. *U.S. Arms Control/Non-Proliferation Policy*: The Consolidated ROD states that the use of the currently operating Watts Bar and Sequoyah reactors has unique advantages not available with any of the other reactor alternatives, including the Bellefonte option, which serve to offset the non-proliferation implications of using these reactors. It is the only option that does not require a very large capital expenditure. It is the only option that allows the nation to pursue the goal of further arms reductions without commitment to construct a major new production reactor. By selecting Watts Bar and Sequoyah, the nation is assured of a long-term option to make tritium, which may not have to be exercised for many years if arms reduction efforts are successful, as is hoped by DOE. By not committing itself to the construction of a major new production reactor, the U.S. can underscore to other nations, especially would-be proliferate nations, its continuing pursuit of smaller nuclear weapons stockpiles.[1]

[1] Conversion of a civilian power reactor to a weapons reactor has been considered a potential arms control/nuclear proliferation issue. However, the potential implications of such a conversion on nuclear proliferation is beyond the scope of this case study and thus has not been analyzed.

3. *Capacity and Schedule*: The Bellefonte alternative and the Watts Bar/Sequoyah alternative could both achieve a production capacity of about 3 kilograms of tritium per year. No matter which reactor alternative is selected, the first batch of tritium could begin production in early FY 2004 when the Watts Bar reactor is scheduled to complete a refueling outage. Because many technical and regulatory issues have been addressed already, there is a high degree of confidence that this initial irradiation schedule can be met. The first batch of tritium gas could be delivered to the stockpile as soon as the Tritium Extraction facility (TEF) is operational, i.e., no later than February 2006. To supply tritium to meet national security requirements, DOE could use one or more reactors. Considering that a maximum number of 3,400 TPBARs could be irradiated in a single reactor, at least two reactors would be needed to irradiate 6,000 TPBARs based on an 18-month refueling cycle. Considering also that additional spent nuclear fuel generation attributed to tritium production starts with the irradiation of approximately 2,000 TPBARs in a single reactor, DOE could use as many as three reactors to irradiate 6,000 TPBARs without increasing the amount of spent nuclear fuel generated by the reactors. Given that DOE could use one or more reactors (i.e., one reactor, two-reactor, or three-reactor combinations), mathematically, DOE had the option of selecting 1 of the 18 combinations of reactor units. These 18 combinations formed the reasonable alternatives of the irradiation element of the project. The impacts for each of the 18 irradiation alternatives would be the sum of the impacts at each of the sites involved.[2] Under current START I requirements, each reactor alternative can achieve capacity requirements. There is a high likelihood that, with adequate funding, each of the reactor alternatives can meet the schedule and the tritium reserve would not be affected.

4. *Regulatory and Licensing Issues*: The Bellefonte alternative would have to be licensed as a new nuclear power plant. The reactor's initial NRC operating license would also permit tritium production. This licensing process is likely to take up to 5 years. This would not affect national security because initial tritium production would begin with the Watts Bar reactor. Delays in getting Bellefonte in operation would, however, delay and possibly reduce DOE's receipt of revenues from Bellefonte power sales, if any. The NRC would have to amend the operating licenses of the Watts Bar and Sequoyah reactors to permit production-scale irradiation of tritium-producing rods. DOE expects that NRC would be in a position to act upon the amendment requests well in advance of the planned October 2003 start of irradiation. Some experience has already been gained in this area because the Watts Bar reactor's operating license was amended to permit the confirmatory test irradiation of 32 TPBARs. The Bellefonte alternative has potential for licensing issues to impact its schedule, but is not likely to affect tritium production. However, delays in getting Bellefonte on line would reduce the Government's receipts from its share of Bellefonte revenues, if any. The Watts Bar/Sequoyah option is not likely to be affected by regulatory issues. Watts Bar and Sequoyah are preferred over Bellefonte because the completion and initial licensing of a new nuclear facility entails greater technical and financial risk than obtaining a license amendment for existing facilities. The "No Action" alternative (i.e., the APT alternative) does not require NRC to issue or amend any reactor licenses.

5. *Environmental Factors*: Construction and operation of the various reactors would require:

- 250 acres of land converted to industrial use for the APT alternative;
- 5.3 acres of previously disturbed industrial land for Watts Bar; and
- 5.47 acres of previously disturbed industrial land for Sequoyah reactors.

Given the use of 1000 TPBARS, the maximum potential increase in annual radioactive atmospheric emissions of tritium would be 100 Curies for the Watts Bar/Sequoyah alternative and 106 Curies for the Bellefonte alternative. For the APT alternative, annual radioactive atmospheric emissions of tritium would be 30,000 Curies in oxide form and 8,600 Curies in elemental form. Both the Bellefonte and APT alternatives would result in increased surface water usage requirements and surface water discharges, whereas the Watts Bar/Sequoyah alternative would result in no change to current surface water usage requirements, discharge, or water quality conditions.

Given the usage scenario of 1,000 TPBARs, the maximally exposed individual will receive a dose increase by:

- 0.013 millirem for Watts Bar alternative;
- 0.017 millirem for Sequoyah alternative;
- 0.263 millirem per unit for Bellefonte alternative; and
- 0.053 millirem for the APT alternative.

Compared to the "No Action" alternative, tritium production at Watts Bar 1, Sequoyah 1, or Sequoyah 2 would generate approximately 0.43 additional cubic meters per year of low-level radioactive waste. This would be a 0.1 (Sequoyah 1 or Sequoyah 2) to 1.0 (Watts Bar 1) percent increase in low-level radioactive waste generation over the "No Action" alternative. Such an increase would amount to less than 1 percent of the low-level radioactive waste disposed of at the Barnwell disposal facility. The EIS also analyzed the impacts of this low-level radioactive waste disposal at the Savannah River Site. Disposing of 0.43 cubic meters per year of low-level radioactive waste would amount to less than 1 percent of the low-level radioactive waste disposed of at the Savannah River Site and less than 1 percent of the landfill's capacity. DOE expects that the overall environmental impacts associated with tritium production in a CLWR would be small. Consequently, the environmental impacts associated with the CLWR alternatives are not considered a major discriminating factor in this decision. Based on all of the environmental factors considered, the use of the Watts Bar and Sequoyah reactors is the environmentally preferred alternative.

The Watts Bar and Sequoyah reactors would each annually generate 0.43 cubic meter of low-level radioactive waste and no additional spent fuel will be generated if less than 2,000 TPBARs are irradiated per 18 month cycle.

Decision Derived from the Final CLWR EIS

In conformance with the Department's December 22, 1998 press release/announcement, the preferred alternative identified in the Final CLWR EIS is the production of tritium in the Watts Bar and Sequoyah reactors. As a result of the programmatic decision in the Consolidated ROD, DOE will produce tritium in a CLWR, and the APT is designated as the back-up technology.

DOE selected the Watts Bar Unit 1 and the Sequoyah Unit 1 and Sequoyah Unit 2 reactors as the specific CLWRs to produce tritium for national security purposes. Compared to completing the Bellefonte reactor, the use of the currently operating Watts Bar and Sequoyah reactors for tritium production would have the:

- Lowest investment cost and lowest life-cycle cost under most-likely scenario;
- Lowest financial risk;
- Greatest flexibility to meet changing requirements;
- Most consistency with stated arms reduction goals; and
- Lowest overall incremental environmental impact.

Tritium Extraction Facility (TEF) Project

The purpose of a TEF is to extract tritium-containing gases from TPBARs irradiated in a CLWR or from targets of similar design, and deliver the tritium-containing gases to Building 233-H, the existing Tritium Loading Facility, for final purification. As described below, DOE evaluated two reasonable alternatives and a "No Action" alternative in the Final TEF EIS.

Alternatives Considered in the Final TEF EIS

1. *Construct a New TEF Facility in the H-Area (Preferred Alternative)*. As identified in the Final TEF EIS, the preferred alternative is to locate the TEF in H-Area, immediately adjacent to and west of Building 233-H within the boundaries of the SRS. The reasons for co-locating TEF close to Building 233-H are: (1) to share common support facilities, services, and some personnel; (2) to facilitate the transfer of tritium between the two facilities; and (3) to use certain gas-handling processes located in H-Area.

2. *Upgrading the Existing Allied General Nuclear Services (AGNS) Facility*. An alternative to constructing a new TEF within H-Area is to refurbish and use the existing Allied General Nuclear Services (AGNS) facility located in Barnwell County, adjacent to the eastern boundary of SRS. The AGNS facility was designed and built according to NRC standards. It would not meet all applicable DOE Orders without major modifications that are discussed in the TEF EIS. Utilization of AGNS would necessitate some new construction and some modifications.[3]

3. "*No Action" Alternative*. Under the "No Action" alternative, DOE would <u>not</u> construct and operate a TEF either at the preferred location in H-Area or at the alternate location at AGNS. Under the "No Action" alternative, the APT facility at SRS could be constructed to handle tritium extraction functions. However, because the use of existing commercial

light water reactors has been chosen as the primary tritium supply, selection of the "No Action" alternative for the TEF would result in the inability to extract tritium from the irradiated TPBARs because under current design specifications, an APT *with* extraction capabilities would not be built. In that case, DOE would not be able to fulfill the purpose and need for the proposed action. Such a decision would be inconsistent with the December 5, 1995 ROD for the Tritium Supply Programmatic EIS, as well as the programmatic decision documented in the Consolidated ROD.

Decision-making Criteria

1. *Cost Factors*. The life-cycle cost estimate for the TEF located at the preferred alternative location (i.e., H-Area) is $920 million compared to the AGNS facility upgrades of $1,085 million. Both estimates are in constant FY 1999 dollars for a 40-year lifetime of these facilities, and do not include long-term stewardship costs. Because of its close proximity to other tritium facilities in H-Area, the H-Area alternative for TEF enables the sharing of common support facilities, services, and some personnel; to facilitate the transfer of tritium between the two facilities; and to use certain gas-handling processes located in H-Area. Consequently the life-cycle cost of operating the TEF for a 40-year lifetime at this location is less than AGNS. The AGNS cost estimate exceeds the TEF estimate due to the added cost of logistics in moving the tritium-containing gases from the AGNS location to the H-Area location for final processing and loading and the additional gas processing equipment needed at the AGNS location. Locating the TEF in the H-Area would have a lower life-cycle cost than locating it at AGNS.

2. *Technical Factors*. Several technical aspects were considered in evaluating the alternatives. For the AGNS facility, these technical aspects included: construction of several new buildings to house the gas processing equipment needed (existing facilities were not large enough to house the needed glove boxes), installation of a drying oven to remove moisture from TPBARs wetted during underwater cask unloading, the addition of a waste processing facility, and an overhaul of the AGNS ventilation system to facilitate the tritium gas processing requirements. Technical factors involving the location of the preferred alternative are: (1) to share common support facilities, services, and some personnel; (2) to facilitate the transfer of tritium between the two facilities; and (3) to use certain gas-handling processes located in H Area.

   The design basis of the Tritium Extraction Facility (TEF) requires that tritium-containing gases be supplied to the existing Tritium Loading Facility (Building 233-H). Extracted gasses would not be isotopically separated at TEF; instead, DOE would utilize existing equipment in Building 233-H for separation of the hydrogen isotopes. In addition, the TEF would not be designed to separate hydrogen and non-hydrogen isotopes. The cost savings to the TEF project by not including this separation equipment is approximately $50 million. If the TEF were built at the AGNS facility, the TEF would have to include all of the necessary separation equipment, as well as the infrastructure required for the facility (electrical, waste water, fire protection, staffing, etc.). The hydrogen isotopic separation equipment would need to "purify" the extracted tritium-containing gases prior to loading on a hydride bed for transporting to the 233-H facility. Additionally, utilization of AGNS would require the unloading of shipping casks underwater which in turn would require the addition of a drying area for the TPBARs prior to extraction. The introduction of water in or around a tritium source greatly increases the hazard to operations personnel in the form of tritium oxide, which is 10,000 times more hazardous to humans than elemental tritium. However, collective doses to the population are expected to equal those of the H-Area TEF alternative. The ability of the preferred alternative to deliver gas directly to the 233-H facility offers several technical advantages over the AGNS alternative.

3. *Human Health Impacts*. A primary difference between the preferred alternative at H-Area and the alternative at AGNS is the latter's proximity to non-government land, and therefore, its greater potential for impacting off-site individuals due to releases near the site boundary. Additional differences include stack height and radionuclides released to the environment. The quantities released at AGNS would differ from those emitted at H-Area because each rod would have to be cut three times in order to fit in the AGNS furnace, while full-height TPBARs would be punctured at H-Area. While processing CLWR TPBARs, the contributions of non-radiological air constituents at AGNS would be 0.13 percent of the applicable standard, and still lower for the onsite H-Area alternative. The radiological dose for the offsite maximally exposed individual would be 0.15 millirem per year for AGNS and 0.02 millirem per year for H-Area. Both of these would be well below the regulatory annual limit of 10 millirem from airborne releases. Because of the location of AGNS, some minority or low-income communities could be disproportionately affected by radiological and nonradiological air emissions; however, such impacts are expected to be minor and within all regulatory standards. Compared to the proposed action, for the maximally exposed individual the AGNS alternative is projected to have a 0.13 millirem per year higher radiation (due to its closer proximity to the boundary) but nearly equal collective population doses.

4. *Waste Generation*. Both the preferred alternative and the AGNS alternative would generate 232 cubic yards of waste annually. The potential impacts to SRS waste treatment, storage, and disposal facilities would be small because the volumes would be small relative to existing waste management capabilities. There is no apparent difference between the two alternatives' generation of waste. The TEF at the H-Area would generate solid and liquid wastes, but no high-level or transuranic waste; waste volumes would have negligible impact on capacities of waste facilities. The TEF at the H-Area would annually produce approximately 230 cubic meters of sanitary solid; 33 cubic meters of industrial waste; 230 cubic meters of low-level radioactive waste; 3.3 cubic meters of hazardous/mixed waste; 770,000 gallons of sanitary wastewater; and 11,000 gallons of nonradioactive process wastewater.

Decision Derived from the Final TEF EIS

As described in the Final TEF EIS, the potential impacts from the preferred alternative or the AGNS alternative on the physical, biological, and human environment would be minor and consistent with what might be expected for an industrial facility. The preferred site for TEF is within H-Area, a densely developed, industrialized area near the center of SRS, approximately 6.8 miles from the nearest (western) SRS boundary. There are four existing tritium-related facilities in the immediate vicinity of the proposed TEF site. Advantages to locating TEF within H-Area include minimal environmental impacts associated with construction and operation of the proposed TEF due to the developed nature of H-Area; availability of site infrastructure (i.e., power, steam, potable water, sewerage); and proximity to existing tritium-related facilities and processes to support TEF operations. Both the nonradiological air constituents and annual radiological dose are lower for the preferred alternative compared to the AGNS alternative. Consequently, the H-Area alternative is the environmentally preferred alternative. The preferred alternative, to design, construct, test, and operate a new TEF in H-Area immediately adjacent to and west of Building 233-H, at the SRS, is selected for implementation. This alternative has the lowest life-cycle cost, has technical advantages, and is environmentally preferred.

Accelerator Production of Tritium (APT) Project

Alternatives Considered and Decision-Making Criteria in the Final APT EIS

The EIS evaluated the "No Action" alternative, and technology and siting alternatives relating to radio frequency power, accelerator operating temperature, feedstock material, cooling water system, APT site, electric power supply, and APT design variations:

1. "*No Action" Alternative*: The "No Action" alternative for the APT is to produce tritium in commercial light water reactor(s) (CLWR) and to construct and operate an associated tritium extraction facility (TEF). Under the "No Action" alternative, the APT is designated the back-up technology for tritium production. DOE would complete key research and development, and preliminary design activities for the APT at SRS (but would not construct the facility) as a back-up source of tritium. The APT would only be constructed in the event that the CLWR option fails to meet tritium capacity requirements. Selection of the APT technology and siting alternatives would support the research and development and preliminary design activities and facilitate implementation should construction and operation of the APT be called for in the future.

2. *Siting Alternatives*: DOE conducted a screening process to select potentially suitable sites within the SRS since it had been decided that the existing tritium recycling facilities within the SRS would be upgraded for use in the tritium project, rather than build any other recycling facilities elsewhere. Based on a weighing and balancing of the criteria, DOE selected two sites for further analysis. The APT EIS evaluated (1) a site 3 miles northeast of the Tritium Loading Facility, and approximately 6.5 miles from the SRS boundary (DOE's preferred alternative); and (2) a site 2 miles northwest of the Tritium Loading Facility, and approximately 4 miles from the SRS boundary.

3. *Operating Temperature Alternatives*: The APT EIS evaluated two operating temperature alternatives for the accelerator: (1) operating electrical components at essentially room temperature, and (2) operating high energy accelerating structures at superconducting temperatures and the rest at room temperature (DOE's preferred alternative).

4. *Feedstock Material Alternatives*: The feedstock material absorbs the neutrons freed during spallation resulting in the production of tritium atom and a byproduct atom. DOE would use the same target/blanket as the neutron source regardless of the feedstock material. The APT EIS evaluated two feedstock materials, (1) helium-3 (DOE's preferred alternative) and (2) lithium-6.

5. *Cooling Water System Alternatives*: The APT requires cooling water to keep target/blanket components, radiation shielding, beamstops and other components from overheating. The APT EIS evaluated four designs to provide the necessary cooling capacity for the APT: (1) mechanical-draft cooling towers with makeup water from the Savannah River and discharge into pre-cooler Ponds 2 and 5 of Par Pond (DOE's preferred alternative); (2) mechanical-draft cooling towers with makeup water from groundwater wells and discharge into the existing pre-cooler Ponds 2 and 5 of Par Pond; (3) once through cooling using Savannah River water and discharge into pre-cooler Ponds 2 and 5 of Par Pond; and (4) use the existing K-Area cooling tower with Savannah River water makeup and discharge to Pen Branch via Indian Grave Branch. A design variation for the first three alternatives would be to discharge the heated water to the head of the existing Pond C of Par Pond but downstream from pre-cooler Ponds 2 and 5. The alternative of mechanical-draft cooling towers with makeup water from the Savannah River is selected as the preferred alternative for the cooling system. The design variation of discharging to the head of Pond C, but downstream from the pre-cooler ponds, was also selected. This alternative is selected because it has the least environmental impacts and avoids additional costs to upgrade the pre-cooler ponds.

6. *Electric Power Supply Alternatives*: APT requires large amounts of electricity to operate. Therefore, DOE evaluated two alternatives for the source of electricity for the APT: (1) obtain electricity from existing commercial capacity and through market transactions (DOE's preferred alternative); (2) obtain electricity from the construction and operation of a new coal-fired or a natural-gas-fired generating plant.

7. *APT Design Variations*: In addition to the cooling water discharge design variation described above, the APT EIS evaluated two other variations. The first is a modular, or staged, accelerator configuration. It would use the same accelerator architecture as the baseline but could be constructed in stages. An initial stage would produce less tritium than the baseline APT but would be capable of producing as much tritium as the baseline APT with the addition of a second stage. The second variation would combine tritium separation and tritium extraction facilities to take advantage of common process systems and would be capable of handling both Helium-3 and Lithium-6 feedstock material. The design variation of combining the tritium separation and tritium extraction processes is not selected since the APT was not selected as the primary tritium source. As currently

envisioned, the APT will not have tritium extraction capabilities since the Tritium Extraction Facility (TEF) will be constructed to support the CLWR (primary) option.

Decision-making Criteria

1. *Siting Alternatives*: The site 3 miles northeast of the Tritium Loading Facility is selected as the preferred APT site. This site is selected because it results in greater buffer distance which would reduce public radiological exposure in case of an incident and less impact to terrestrial and aquatic ecology. The alternative of obtaining electricity from the existing commercial capacity and through market transactions is selected as the preferred alternative for electrical power supply. The alternative is selected because it presents the least environmental impact; it provides the greatest flexibility in reducing costs through using market mechanisms to obtain bulk wholesale costs; and it provides opportunities to use alternative supplies of power.

2. *Operating Temperature Alternatives*: The alternative of using superconducting components is selected as the preferred alternative for specific higher power sections of the accelerator. The use of superconducting components would have reduced electricity demands resulting in lower environmental impacts; greater safety margin due to less chance for activation of the accelerating structures and cooling system that reduces the number of pipe penetrations into the accelerator; and only two cavity sizes allowing for simpler design and maintenance.

3. *Feedstock Material Alternatives*: The alternative using helium-3 as a feedstock material is selected as the preferred alternative for production of tritium. The use of helium-3 as a feedstock material would have the least environmental impact; greater flexibility in extracting the tritium on a semi-continuous basis; and greater safety margin because the inventory of tritium in the target blanket.

4. *Electric Power Supply Alternatives*: The modular design is selected as the preferred design for the APT because it provides capacity and cost flexibility in meeting changing tritium requirements.

5. *Waste Generation*: The APT at the SRS would generate solid and liquid wastes, but no high-level or transuranic waste; waste volumes would have negligible impact on capacities of waste facilities. Generation of electricity will generate various types of waste including fly ash, bottom ash, and scrubber sludge. The APT would annually produce 1,800 metric tons of sanitary solid; 3,800 metric tons of industrial waste; 140,000 gallons of radioactive wastewater; 1,400 cubic meters of low-level radioactive waste; 12 cubic meters of high concentration waste under evaluation; 3.2 million gallons of sanitary wastewater; and 920 million gallons of nonradioactive process wastewater.

Decision Derived from APT EIS

DOE selected the APT as the back-up tritium supply technology and thus, DOE will complete preliminary design for the APT facility (without tritium extraction capabilities). To focus this design effort, DOE has made the above selections for the different sets of alternatives and design variations described and analyzed in the engineering and environmental documents.

ENDNOTES

1. U.S. Department of Energy. March 1999. Final Environmental Impact Statement for the Production of Tritium in a Commercial Light Water Reactor. (DOE/EIS-0288) *http://www.dp.doe.gov/dp-62/default.htm*

2. U.S. Department of Energy. March 1999. Final Environmental Impact Statement: Construction and Operation of a Tritium Extraction Facility at the Savannah River Site (DOE/EIS-0271) *http://www.dp.doe.gov/dp-62/default.htm*

3. U.S. Department of Energy. March 1999. Final Environmental Impact Statement: Accelerator Production of Tritium at the Savannah River Site (DOE/EIS-0270) *http://www.dp.doe.gov/dp-62/default.htm*

4. U.S. Department of Energy. October 1995. Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling (DOE/EIS-0161) *http://www.ymp.gov/documents/deisref/index.htm*